Engineering Library

The Engineer.

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VOL. CXLVIII.—No. 3834] LONDON: FRIDAY EVENING, JULY 5, 1929 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

Assistant Civil Engineers

REQUIRED in Civil Engineer-in-Chief's Department, Admiralty, and H.M. Naval Establishments at home and abroad. Candidates must be between the ages of twenty five and thirty years on the 20th July, 1929; those who have served, or are serving, in the Army, Navy or Air Force may deduct from their actual age any time, not exceeding three years, during which they have so served. Candidates must either (a) be Corporate Members of the Institution of Civil Engineers or (b) have passed sections A and B of the Associate Membership Examination of the Institution of Civil Engineers, or taken a Degree recognised by the Institution as exempting therefrom, and have reached such a stage in their professional training that it is possible for them to become Corporate Members within two years.

Those appointed will be on probation for two years, and will not be confirmed unless and until they, being Corporate Members of the Institution of Civil Engineers, have passed this period of probation to the satisfaction of the Admiralty.

Commencing salary £250 per annum, plus Civil Service bonus, which at the current rate amounts to £111 per annum.

Special consideration will be given to candidates who served in H.M. Forces during the War.

No candidate will be accepted for appointment who fails to pass a strict medical examination as to his physical fitness.

Forms of application, &c., can be obtained from the CIVIL ENGINEER-IN-CHIEF, Admiralty, London, S.W. 1, and should be returned, completed, so as to reach that officer not later than 20th July, 1929.

Candidates will be responsible for any expenses which they may incur in attending for interview. 2231

Crown Agents for the Colonies.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POST :—

M/1569.—ASSISTANT DISTRICT ENGINEER REQUIRED by the GOVERNMENT of CEYLON for the Railway Department for three years' service, with possible extension. Salary £450, rising to £600 a year by annual increments of £30. Candidates, preferably unmarried, between the ages of 26 and 31, should have passed Sections "A" and "B" of the examinations for the A.M.I.C.E. Diploma or hold professional qualifications recognised by the Institution of Civil Engineers as exempting from those examinations. Should have had at least three years suitable experience on Railway Construction or on Maintenance Work. Must be capable of assisting a District Engineer in charge of a district of about 200 miles, carrying on any or all the duties of the District Engineer if and as required. Should be capable of designing bridges, buildings and other structures with all calculations necessary for these works.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/1569. 2455

Royal Indian Marine.

APPOINTMENT OF ENGINEER OFFICERS.

The Secretary of State for India proposes shortly to make a number of APPOINTMENTS of ENGINEER SUB-LIEUTENANTS in the Royal Indian Marine. Candidates must be British subjects, between the ages of 21 and 23, and must have served at least five years as apprentice engine fitters in a recognised engineering firm or Government dockyard. Selected candidates will be given three months' training under the Admiralty before proceeding to India.—Further details and forms of application from the SECRETARY, Military Department, India Office, S.W. 1. Applications should be made immediately. 2361

IN THE MATTER of LETTERS PATENT granted to Walter Jones and Jones and Attwood Limited

(1) Bearing date the 11th October 1913 and numbered 22952 of 1913 for the invention of "Improvements in Apparatus for the Aeration of Sewage and other Foul Liquids"

(2) Bearing date the 10th January 1914 and numbered 729 of 1914 for the invention of "Improvements in Apparatus for the Purification of Sewage or other Impure Waters"

(3) Bearing date the 11th April 1914 and numbered 16916 of 1914 for the invention of "Improvements in or connected with Apparatus for the Purification of Sewage and Analogous Liquids"

(4) Bearing date the 4th November 1914 and numbered 21976 of 1914 for the invention of "Improvements in or connected with the Purification of Sewage and Analogous Liquids"

(5) Bearing date the 10th November 1914 and numbered 22736 of 1914 for the invention of "Improvements in and connected with the Purification of Sewage and Analogous Liquids"

(6) Bearing date the 19th November 1914 and numbered 22737 of 1914 for the invention of "Improvements in and connected with the Purification of Sewage and Analogous Liquids."

Notice is Hereby Given that

on the 30th July 1929 an ORIGINATING SUMMONS (1929 J. No. 867) issued out of the High Court of Justice (Chancery Division) on behalf of Ernest Reginald Jones, John Donaldson Harward, Percy Alexander Sandford (the personal representatives of Walter Jones deceased), Jones and Attwood Limited and Activated Sludge Limited asking that the terms of the above-mentioned Letters Patent may respectively be extended for five years will come before Mr. Justice Luxmoore for directions as to the hearing and any person desirous of being heard in opposition must at least seven days before that date lodge notice of opposition (giving an address for service within the United Kingdom) at Room No. 175, Royal Courts of Justice, Strand, London, and serve a copy thereof upon the undermentioned Solicitors and upon the Solicitor to the Board of Trade.

Dated this 27th day of June, 1929.

BRISTOWS COOKE & CARPMAEL,
1, Copthall-buildings, London, E.C. 2,
Upon whom all documents requiring service should be served. 2413

Borough Polytechnic Institute,

BOROUGH-ROAD, LONDON, S.E. 1.

LECTURER IN ENGINEERING SCIENCE (SECOND YEAR).

The Governors invite APPLICATIONS for the POST of VISITING LECTURER in ENGINEERING SCIENCE (2nd Year) for two or three evenings a week, commencing in September, 1929. Conditions of appointment and forms of application may be obtained from the undersigned.

J. W. BISPHAM,
Principal.
2422

The Engineer

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Robert Gordon's Colleges,

ABERDEEN.

The Governors invite APPLICATIONS for the POST of HEAD of the MECHANICAL ENGINEERING DEPARTMENT.

Candidates must be University Graduates in Engineering and have had thorough practical training in Mechanical Engineering and experience of instruction. Salary scale £500-£600 per session.

The Engineering Department of the College co-operates with the University of Aberdeen in providing Degree Courses in Engineering.

A statement of the duties attaching to the appointment may be had from the undersigned, with whom 17 copies of letter of application and of testimonials should be lodged not later than 29th July, 1929.

JAMES McKENZIE,
Secretary and Registrar.
2411

MANCHESTER MUNICIPAL
COLLEGE OF TECHNOLOGY.

Principal:
B. MOUAT JONES, D.S.O., M.A. (Oxon).

UNIVERSITY OF MANCHESTER.
(FACULTY OF TECHNOLOGY).
DEGREE COURSES IN TECHNOLOGY.

The Prospectus gives particulars of the courses leading to the Manchester University Degrees (B.Sc. Tech., M.Sc. Tech., and Ph.D.), and Certificates in the Faculty of Technology, in the following Departments:—

MECHANICAL ENGINEERING
(Prof. Dempster Smith, M.B.E., M.Sc. Tech., M.I.M.E.).
ELECTRICAL ENGINEERING
(Prof. Miles Walker, M.A., D.Sc., M.I.E.E.).
MUNICIPAL AND SANITARY EGYINEERING
(G. S. Coleman, D.Sc. Eng., A.M. Inst. C.E., A.M. Inst. M. and Cy. E., F.R. San. I.).
APPLIED CHEMISTRY, including General Chemical Technology, Chemistry of Textiles (Bleaching, Dyeing, Printing and Finishing), Paper Manufacture, Metallurgy and Assaying, Chemical Technology of Brewing, Electro-chemistry, Photography, Colouring Matters, Foodstuffs, and Fuels
(Prof. James Kenner, D.Sc., Ph.D., F.R.S.).
TEXTILE TECHNOLOGY
(Professor W. E. Morton, M.Sc. Tech.).
INDUSTRIAL ADMINISTRATION (Post-Graduate Certificate Course)
(J. A. Bowie, M.A., D.Litt.).

Prospectus will be forwarded free on application to the REGISTRAR, College of Technology, Manchester. 2089

PUBLIC NOTICES

University of Liverpool.

FACULTY OF ENGINEERING.

Dean: Professor G. E. SCHOLES, M.B.E., M.Sc., M.I.A.E., M.I. Mech. E.

Prospectus and full particulars may be obtained on application to the REGISTRAR of Courses designed for Students desiring to qualify as Mechanical, Electrical, Civil or Marine Engineers, as Naval Architects or as Metallurgists and Metallurgical Engineers. 2473

Bombay, Baroda and Central India Railway Company.

The Directors are prepared to receive up to Noon on Friday, 26th July, TENDERS for the SUPPLY of:—

1. ELECTRIC OVERHEAD TRAVELLING CRANES, &c.
2. STEEL MATERIAL (PLATES, FLATS AND ROUNDS).

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of £1 each for No. 1 and 10s. each for No. 2 (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France, Westminster, S.W. 1,
3rd July, 1929. 2447

Borough of Richmond (Surrey).

WATER DEPARTMENT.
WELL IN OLD DEER PARK (NO. 2).
CONTRACT NO. 2.
TENDERS FOR PUMP, MOTOR, &c.

The Corporation invite TENDERS for an ELECTRICALLY DRIVEN CENTRIFUGAL PUMP with MOTOR, &c., complete, capable of pumping a continuous supply of 190 gallons per minute against a total head of 60ft.

Full particulars and form of Tender may be obtained from Mr. Hugh P. Williamson, M.C., M. Inst. C.E., Engineer and Manager, Hotham House, Heron Court, Richmond, Surrey, on payment of £2, which will be returned on receipt of a bona fide Tender and the return of all documents, &c., supplied.

Sealed Tenders to be delivered to the Town Clerk, Town Hall, Richmond, Surrey, not later than 10 a.m. on Monday, the 15th July, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

EDWIN M. NEAVE,
Town Clerk.
Town Hall, Richmond, Surrey,
July, 1929. 2417

PUBLIC NOTICES

City of Bradford.

HARROGATE-ROAD CANAL BRIDGE.

The City Council invite TENDERS for the SUPPLY and DELIVERY of about 73 TONS of COMPOUND STEEL GIRDERS, BED-PLATES and TIE RODS, &c., required in connection with the above Bridge.

General conditions, specifications, plans and form of Tender may be obtained on application to Mr. F. Mardsen, City Engineer and Surveyor, Town Hall, Bradford.

Tenders, sealed and endorsed "Compound Steel Girders Tender," are to be delivered to me not later than Twelve o'clock Noon on 21st July, 1929.

N. L. FLEMING,
Town Clerk.
Town Hall, Bradford,
29th June, 1929. 2418

County Borough of Belfast.

TENDERS FOR THE SUPPLY OF ONE MOTOR STREET SWEEPING MACHINE AND COLLECTOR.

The Improvement Committee invite TENDERS for the SUPPLY of ONE MOTOR STREET SWEEPING MACHINE and COLLECTOR.

Forms of Tender and particulars may be obtained at the office of the City Surveyor, Mr. R. B. Donald, M. Inst. C.E.

Sealed Tenders, on official forms only, accompanied by drawing and specifications of machines tendered, enclosed in envelope supplied with the Tender forms, endorsed with the name and address of the firm tendering, and marked "Tender for Motor Street Sweeping Machine and Collector, Surveyor's Department," to be lodged or posted so as to arrive in my office not later than Monday, July 22nd, 1929.

An official receipt must be obtained for every Tender delivered by hand. Tenders sent by post should be registered.

The lowest or any Tender will not necessarily be accepted.

R. MEYER,
Town Clerk.
2446

Manchester Corporation WATERWORKS.

HAWESWATER—ROADS AND SIDINGS.

The Waterworks Committee invite TENDERS for the CONSTRUCTION of WORKS ROADS, approximately 5½ miles in length, commencing at a point near the Shap Granite Works and terminating at Naddle Beck, Haweswater.

Printed specification, schedule of quantities, and form of Tender may be obtained on and after the 10th instant on application to the Engineer, Waterworks Offices, Town Hall, Manchester, on payment of a deposit of Five Guineas, which will only be returned to the tenderer provided that he shall have sent in a bona fide Tender.

Detailed plans and sections may be seen either at the Waterworks Offices, Manchester, or at the Shap Office, Main-street, Shap, between the hours of 10 a.m. and 3 p.m. on the 15th, 16th, and 17th instant, and an Engineer will attend at 10 a.m. on the same dates at the Shap Office in order to conduct representatives of those who have previously obtained a copy of the specification, &c., over the track of the intended roads.

Sealed Tenders, endorsed as directed in the schedule, must be delivered at the Waterworks Offices, Town Hall, Manchester, not later than the 24th of July, 1929.

By Order,
F. E. WARBRECK HOWELL,
Town Clerk.
Town Hall, Manchester. 2454

The Egyptian Government.

ASWAN DAM.

With reference to previous notices with regard to the HEIGHTENING of the ASWAN DAM on the River Nile, the DATE on which the TENDERS both for the Masonry Work and for the Modifications and Additions to the Sluice and Lock Gates must be submitted to HIS EXCELLENCY the MINISTER OF PUBLIC WORKS, Cairo, Egypt, has been ALTERED to MID-DAY on OCTOBER 1st, 1929, instead of September 14th, 1929, as previously advertised. 2456

NORTHERN INDIA
ENGINEERING DEVELOPMENT.

Many huge projects are completed, others are under construction, and still more are under consideration. When tendering, remember that we have handled, inter alia, all the material for the Lloyd Barrage, the largest irrigation scheme in the world, and that WE HAVE THE EXPERIENCE to enable us to quote you the most favourable terms for CLEARING and DESPATCHING up country any quantity of material to any site required.

For full particulars apply, EASTERN EXPRESS CO., Ltd., Karachi; or to Messrs. FORBES, FORBES, CAMPBELL and CO., Ltd. (Managing Agents), 9, King William-street, London, E.C. 4. P 5899

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PUBLIC NOTICES

Stowmarket Urban District

COUNCIL WATERWORKS.
CONTRACT NO. 2.
TO CONTRACTORS FOR REINFORCED CONCRETE WORKS.

The Stowmarket Urban District Council are prepared to receive TENDERS for the ERECTION of a REINFORCED CONCRETE WATER TOWER of 50,000 gallons capacity and about 75ft. in height, with other appurtenant WORKS, in accordance with the plans and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

Copies of the specification, bill of quantities and form of Tender may be obtained at the offices of the Engineers upon payment of £5 (cheque only), which will be returned on receipt of a bona fide Tender.

The drawings may be seen at the offices of the Engineers.

Tenders, in sealed envelopes, addressed to the undersigned and endorsed "Tender for Water Tower," must be delivered at my offices, Buttermarket, Stowmarket, on or before 10 a.m. on Tuesday, the 23rd day of July, 1929.

The Council does not bind itself to accept the lowest or any Tender.

(Signed) P. C. HAYWARD,
Clerk to the Council.
2441

Borough of Bexhill.

ASSISTANT WATER ENGINEER.

APPLICATIONS are INVITED for the POSITION of ASSISTANT WATER ENGINEER. Candidates must have sound knowledge of Oil and Electric Pumping Plant, Deep Well and Bore-hole Pumps, and the preparation of plans and specifications for the carrying out of all new work required in a water undertaking.

The person appointed will be required to act directly under the Borough Water Engineer.

Preference will be given to applicants who are connected with the Institute of Water Engineers.

Salary to commence at £250 per annum, rising by two equal annual increments to £300.

Applications, endorsed "Assistant Water Engineer," giving full particulars of age, experience and qualifications, together with copies of not more than three recent testimonials, to be received by me not later than Friday, July 12th.

Canvassing, either directly or indirectly, will disqualify.

S. J. TAYLOR,
Town Clerk.

Town Hall, Bexhill,
26th June, 1929. 2366

Borough of Bexhill.

ASSISTANT WATER INSPECTOR.

APPLICATIONS are INVITED for the POSITION of ASSISTANT INSPECTOR in the WATERWORKS DEPARTMENT. Candidates must have experience of the Recovery of Waste, a knowledge of Plumbing, and be able to carry out Repairs and Read and Repair Water Meters. Night inspection will have to be undertaken when necessary.

The person appointed will be required to act directly under the Borough Water Engineer.

Wages £3 per week, rising by two annual increments at the rate of 5s. per week each to £3 10s. per week, subject to satisfactory service.

Applications, endorsed "Water Inspector," giving full particulars of age, qualifications and experience, and accompanied by copies of testimonials, to be addressed to the undersigned so as to be received not later than Friday, July 12th.

Canvassing, either directly or indirectly, will disqualify.

S. J. TAYLOR,
Town Clerk.

Town Hall, Bexhill,
26th June, 1929. 2367

City of Liverpool.

TEMPORARY ENGINEERING DRAUGHTSMAN.

APPLICATIONS are INVITED for a TEMPORARY APPOINTMENT as CIVIL ENGINEERING DRAUGHTSMAN in the City Engineer's Department for a period of about two years.

Applicants should be good draughtsmen and have had experience in Railway Work, especially regarding the construction of Tunnels and Heavy Masonry Structures.

The duties will be to prepare working drawings and make necessary calculations.

The appointment may be terminated by one week's notice on either side.

Salary £8 per week.

Applications, stating qualifications and accompanied by copies of not more than three recent testimonials, to be forwarded through the post, addressed to the undersigned, endorsed "Engineering Draughtsman," so as to arrive not later than the first post on Friday, 12th July, 1929.

Canvassing, directly or indirectly, will be deemed a disqualification.

WALTER MOON,
Town Clerk.

Municipal Offices, Liverpool,
3rd July, 1929. 2467

India State Railways.

GREAT INDIAN PENINSULA RAILWAY.

A POWER STATION CHARGE ENGINEER is REQUIRED for service on the above Railway. Only British subjects are eligible. The Power Station is situated at Kalyan, about 30 miles from Bombay. The equipment of the Station comprises four 10,000 kW turbo-alternator sets and six Babcock and Wilcox water-tube coal-fired boilers, each of a maximum capacity of 105,000 lb. of steam per hour. Oil fuel equipment is also installed. Candidates must have held a similar post in a modern Power Station.

SALARY.—The salary paid will depend upon candidate's age and qualifications and will be not less than Rs. 525 per mensem, rising to Rs. 1375 per mensem, including allowances. Salary will be payable from the date of landing in India, subject to rules in force.

The appointment is for three years, but is extensible on mutual agreement.

A free first-class passage to India will be provided on appointment.

The selected candidate will be required to pass a strict medical examination, and should be preferably not more than 38 years of age.

Application must be made by letter only and all applicants should state their age, salary required, whether married or single, and give full details of their education and career to date.

Applications, accompanied by copies only of testimonials, should be addressed to the undersigned not later than the 10th July, 1929.

MERZ AND PARTNERS,
32, Victoria-street, London, S.W. 1.
2423

Metropolitan Water Board.

APPOINTMENT OF TWO JUNIOR ENGINEERING ASSISTANTS.

The Metropolitan Water Board invite APPLICATIONS from those who are students of the Institution of Civil Engineers or have passed an examination qualifying for studentship for the APPOINTMENTS of TWO TEMPORARY JUNIOR ENGINEERING ASSISTANTS in the department of the Chief Engineer, at an inclusive salary of £3 per week.

Applications, in the candidates' own handwriting, stating age and full particulars of training and qualifications, should be addressed to Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, and must reach the offices of the Board not later than the 15th July, 1929.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1.
26th June, 1929. 2364

Wakefield Corporation Waterworks.

WANTED, TEMPORARY JUNIOR ENGINEERING ASSISTANT. Must have completed University Course and obtained Diploma. Salary £150 per annum.

Applications to be accompanied by two testimonials, to be sent to C. CLEMESHA SMITH, M. Inst. C.E., Waterworks Engineer, Town Hall, Wakefield. 2416

YARROW HOME and HOSPITAL
FOR CHILDREN
BROADSTAIRS.

For the Early & Preventive Treatment of Disease & Convalescence after illness.

In these days of high cost of living, people of limited means are sometimes placed in a difficulty when their children are ill or need operations and afterwards require a change of air and much careful attention during convalescence. It cannot be too well known that the Yarrow Home and Hospital for Children, Broadstairs, Kent, was founded specially for the children of those who are not too well endowed with this world's goods. At this Home a child recovering from illness or an operation, or needing a long course of medical or surgical treatment, receives, amid the happiest possible surroundings and companionship, careful nursing and attention, such as could ordinarily only be obtained at expensive nursing homes. There are beds for fifty boys between the ages of four and twelve years, and for fifty girls between the ages of four and fourteen years. In special cases these age limits may be exceeded by two years. The fee is one guinea per week and travelling expenses. Applications for the entrance of patients are welcomed from professional people, such as members of the Institution of Civil Engineers, architects, artists, authors, clergymen, members of the medical, legal, and other professions, members of scientific societies, officers of the Navy, Army, and Royal Air Force, officers of the merchant navy, school masters, university professors, &c. The London office is at 116, Victoria-street, Westminster, and the Secretary will be pleased to send full particulars to anyone who is interested.

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED by the FRANCOIS CEMENTATION CO., Ltd., Bentley Works, Doncaster, a JUNIOR ENGINEER, with some knowledge of Cement and Plain and Reinforced Concrete. Salary from £220 to £30 monthly, depending on age, experience and qualifications. 2428 A

ASSISTANT WORKS MANAGER WANTED IMMEDIATELY for works in Manchester district employing 1000. The following experience is necessary:—Modern Machine Shop and Fitting Practices, Planning, Rate Fixing, Tool Design and Manufacture, efficient Works Organising ability. Must be strict disciplinarian with initiative. State in full experience, age, salary, and when at liberty.—Address, 2460, The Engineer Office. 2460 A

CONTRACTORS, S.W., REQUIRE Smart ASSISTANT. Small factory bldgs. supervision. Good scope young engr. State wages and exp.—Address, P5969, The Engineer Office. P5969 A

EDITOR REQUIRED by an Engineering Institution with headquarters in London. Monthly publication of journal entails part time only. Experience of Technical Literature essential.—Address, stating full particulars of training and experience, 2429, The Engineer Office. 2429 A

ENERGETIC MAN REQUIRED, to Take Charge of the Steam Side of a 6000 kW Power-house fitted with turbo generators and Babcock and Wilcox chain-grate stokers, also to be responsible for the running of various boilers, air compressors, heating apparatus, and water services in a large Sheffield steel works; electrical knowledge an advantage, but not essential.—Address, with age, experience, salary required, and state when services would be available, 2421, The Engineer Office. 2421 A

MATERIALS HANDLING DESIGNERS WANTED to Prepare Schemes. Should be experienced in design of Structures, Storage Bins, Conveyor Machinery, and in Listing Quantities. Locality South of England.—Write, stating age, experience, and salary required, to Box 899, Sells Advertising Offices, Fleet-street, E.C. 4. 2448 A

QUALIFIED ENGINEER REQUIRED to Manage large Limestone Quarry in Staffordshire. Must be thoroughly conversant with all phases of Quarry Working, including knowledge of Explosives, Crushing Plants, Pumping Machinery, Handling of Labour, &c.—Address, stating qualifications, age, and salary required, 2427, The Engineer Office. 2427 A

REQUIRED for a Large Engineering Firm in India, DRAWING-OFFICE ASSISTANT for the Shipyard Department, with thorough experience of estimating and design of all types of Steam and Petrol-driven Launches and Vessels, mainly of the river craft and light sea-going type. Applicants should also be able to interview clients and conduct a certain amount of office correspondence. Copies of testimonials should accompany reply, and questions of salary and terms of appointment would be discussed at the interview in London.—Write to Box Z.Z. 622, c/o Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 2452 A

REQUIRED to Teach Engineering Subjects at Oundle School, an HONOURS GRADUATE (ENGINEERING). It is desirable, but not essential, that candidates should have had drawing-office and works experience.

Would intending candidates write as soon as possible to the HEADMASTER, Oundle School? P5970 A

TIME STUDY.—MAN with Experience in Fixing Piecework Prices from drawings for Machine Shops. Must be able to draw out own set-ups on combination turret lathes, milling machines, &c. It is essential that applicants be used to Steel Castings of repetition nature for Commercial Vehicles.—Address, giving full particulars of age, experience, and salary required, 2314, The Engineer Office. 2314 A

VACANCY for ARTICLED PUPIL in Well-known Firm of Consulting Engineers and Architects in Westminster.—Address, P5957, The Engineer Office. P5957 A

YOUNG ENGINEER with Means REQUIRED to Co-operate in Developments of Important Patents. No cash investment necessary. Excellent prospects with old-established firm for capable energetic man.—Address, 2459, The Engineer Office. 2459 A

WANTED for Cement Machinery Manufacturers, DRAUGHTSMEN experienced in the design of Cement Machinery and Plant. Only those with this experience need apply.—Address, giving age, salary, and experience, 2440, The Engineer Office. 2440 A

WANTED, SENIOR DRAUGHTSMAN, for an old-established (British) Firm of Constructional Engineers and Shipbuilders in India. Applicant must have served full apprenticeship in engineering workshops with subsequent technical training at recognised Engineering College or University and obtained B.Sc. or B.E. Degree. In addition to general mechanical engineering, must have had considerable experience in the design of Bridge Structures and preparation of competitive designs for all classes of steel work. Public school man preferred and age under 35. A four years' agreement in the first instance, first-class free passage to India and home again on satisfactory termination of services. Excellent prospects for first-class man.

Address, with full particulars of experience, references, and salary expected, 2339, The Engineer Office. 2339 A

WANTED, SENIOR DRAUGHTSMAN, with Machine Tool experience, for Midlands. State full experience, age, and salary required.—Address, 2435, The Engineer Office. 2435 A

SITUATIONS OPEN (continued)

WANTED, Smart JUNIOR DRAUGHTSMEN, Preferably with experience in Centrifugal Pumps and Refrigerating Machinery, for works in the South of England.—Address, giving full particulars of experience and salary required, 2443, The Engineer Office. 2443 A

A FEW SENIOR and JUNIOR DRAUGHTSMEN REQUIRED at Derby Works, with good technical training and preferably with experience in Boiler-house or Coal-handling Equipment. State age, salary required, and when at liberty.—COMBUSTION ENGINEERING, Ltd., Derby. 2261 A

DESIGNER WANTED, with First-class Knowledge of Modern Machine Tools. Applications will only be considered from really A1 men. State age, experience, and salary required. Good salary will be paid to really able man.—Address, 2430, The Engineer Office. 2430 A

DRAUGHTSMAN DESIGNER REQUIRED. One able to work out detailed design from general idea.—Apply in first instance by letter only, stating age, salary required, experience, &c., to DEAN, SMITH and GRACE, Limited, The Lathe People, Keighley. 2457 A

DRAUGHTSMAN.—ENGINEERING DRAUGHTSMAN REQUIRED temporarily for Railway Engineer's Office in London; experience in Permanent Way and Surveying essential.

Address, stating age, experience, and salary required, 2341, The Engineer Office. 2341 A

DRAUGHTSMAN, JUNIOR, REQUIRED, with experience of Small Jigs and Tools, for works in Enfield District.—Address, giving full particulars, 2434, The Engineer Office. 2434 A

DRAUGHTSMAN REQUIRED for Leading Automobile Concern, Coventry district. Give fullest particulars, including experience, age, and salary required.—Address, 2370, The Engineer Office. 2370 A

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For continuation of Small Advertisements see page 4.

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JULY 5, 1929.—VOL. CXLVIII.

THE ENGINEER.

A Seven-Day Journal

National Research and the Electrical Industry.

THE British Electrical and Allied Industries Research Association has for the past eight years carried out a series of far-reaching investigations, with results of great value to the country in general, and in particular to all interested in the production, supply, and use of electricity. The Association was originally founded under the scheme of research associations developed by the Department of Scientific and Industrial Research, and has received from the Government financial support, without which its work would have been impossible. This support has, in accordance with the approved policy for research associations, been on a diminishing scale, and, under the present scheme, terminates next year. Meanwhile, the demands on the Association by the industry are steadily increasing, and it is, we are informed, urgently necessary that it should receive help on a more liberal scale than hitherto. While the Association has in the past derived its main support from the manufacturers, they alone, it is held, cannot be expected to accept the responsibility of replacing the assistance hitherto accorded by the Government. An appeal is now being made to the manufacturers, the authorised undertakers throughout the country, both local authority and company, and consumers of electricity, to take their part in an effort to obtain further financial support. The appeal is signed among others by Sir John Snell, the Chief Electricity Commissioner; Sir Andrew R. Duncan, the Chairman of the Central Electricity Board; Colonel K. Edgcumbe, President of the Institution of Electrical Engineers; Dr. S. Z. de Ferranti, President of the British Electrical Development Association; and Sir R. T. Glazebrook.

Twenty-five Years of the Cornish Riviera Express.

WITH the arrival of the Cornish Riviera express at Plymouth on Monday, July 1st, the Great Western Railway completed twenty-five years of that celebrated service. The train is now timed to do the non-stop run of over 200 miles from Paddington to Plymouth in four hours and to reach Penzance in 6 hours 20 min. During the quarter century of its existence the service has run a total of five million miles and has carried between three and four million passengers. To commemorate the silver anniversary of the service two new sets of coaches for it have been constructed at Swindon. These coaches will be used for the first time on Monday next, the day on which the summer service comes into operation. They will be found to contain new features and many refinements. Among the novelties is the use of "Vita" glass in the windows. Practically all the timber used in the construction of the new coaches is of British Empire origin.

Seamen and Transport Workers.

AN involved and possibly threatening situation has arisen in the shipping industry as a result of certain differences between the National Union of Seamen and Firemen and the Transport and General Workers' Union over the question of the signing on of ships' crews. The National Maritime Board is a body composed jointly of representatives of the shipowners and of the different ratings employed on ships, and deals with various questions, such as those of wages and conditions. There is an understanding with the Board that all the employees on the ships coming within its sphere shall be members of a union affiliated to the Board. The Seamen's Union is the only affiliated union which caters for the seamen, firemen, and stewards. To satisfy the officers when a crew is being engaged, the men must produce the Maritime Board's engagement form P.C. 5—port consultant's form. Acceptance of this form means that the holder is a subscribing member of the Seamen's Union, no other organisation being recognised by the Board. Many of the men—for example, 95 per cent. of those employed on the Southern Railway's steamers sailing from Southampton—are members of the Transport Workers' Union, and in the past have, in order to obtain employment, found themselves compelled to pay subscriptions to a union other than their own. The Transport Workers' Union has appealed to the Board for recognition, but the Board is apparently unwilling to move in that direction. At Southampton trouble arose in connection with the re-signing of the six-monthly articles. It was alleged that no member of the Transport Workers' Union who was not prepared to cease his membership of that union was being allowed to re-sign. Similar trouble also arose at Heysham and at Leith. At Belfast nearly a hundred of the quayside workers became involved in the trouble, and went on strike. At the moment of going to press it is somewhat difficult to discover what the precise situation is. At Southampton a satisfactory agreement appears to have been reached, but at London and Liverpool, as at Belfast, the dockers have become involved in the dispute.

The Great Western's New General Manager.

AT the end of last week it was announced that Mr. James Milne had been appointed general manager of the Great Western Railway Company, in succession to Sir Felix Pole, who has accepted the chairmanship of Associated Electrical Industries. Mr. Milne is forty-six years of age and has spent twenty-five years in the service of the Great Western. Since March, 1924, he has been the company's assistant general manager. He began his career with the company in 1904 as a pupil in the locomotive department. After passing through the shops at Swindon he was transferred to Paddington, where he served under the superintendent of the line and the general manager. In 1912 he was in charge of the passenger train running department, and in January, 1916, he became chief clerk to the divisional superintendent at Pontypool. Subsequently he served as divisional superintendent at Swansea and at Plymouth. In September, 1919, he was appointed to the statistical department of the Ministry of Transport. He was specially selected to serve on the Committee on National Expenditure and later was chosen by Lord Inchcape to serve on the Indian Retrenchment Committee.

The Lower Thames Tunnel Scheme.

FOR a number of years past many people have advocated the construction of a tunnel under the Thames between Tilbury and Gravesend, or alternatively between Dartford and Purfleet. Among those who actively associated themselves with the scheme was the late Sir Alexander Richardson during the time when he was member of Parliament for the Gravesend division. It would appear that among the schemes for providing employment which the Government has in view, the construction of a lower Thames tunnel is being considered. At the request of the Ministry of Transport, the Essex County Council on Tuesday considered the question, and decided to co-operate with the Kent County Council and the Ministry of Transport in the matter of engaging surveyors to report on the scheme. No decision as to the precise situation for the tunnel will be taken until the surveyors' report is received. As regards the cost of the work, it may be recalled that last April the Minister of Transport stated in the House of Commons that a tunnel between Dartford and Purfleet would cost about £3,000,000, while an additional £800,000 would be required for contingent road works.

Reconstructing a Chilean Dreadnought.

LAST autumn, when the Chilean Government decided that the super-dreadnought battleship "Almirante Latorre" should be thoroughly modernised, the British Admiralty dispatched a party of officers and engineers to Valparaiso to survey the vessel for the purpose of submitting a bid for the work of reconstruction. The Admiralty's tender was duly submitted and accepted, and the battleship has now arrived at Devonport, where the work to be done on her is to be begun immediately. An order for the new turbine machinery with which the vessel is to be fitted has been placed with Vickers-Armstrongs, Ltd., of Barrow. It is understood that the vessel's entire fighting equipment will be modernised, and that her protection against aircraft, gun-fire and torpedo attack will be improved. It is possible that she may be fitted with bulges. The "Almirante Latorre" was launched for the Chilean Navy at Elswick in November, 1913. On the out break of war she was bought by this country, and in September, 1915, was commissioned as H.M.S. "Canada." She served throughout with the Grand Fleet and was present at Jutland. In April, 1920, she was re-purchased by Chile. A sister vessel, the "Almirante Cochrane," was also bought by the Admiralty in 1914, and was subsequently converted into the aircraft carrier H.M.S. "Eagle." That vessel last Saturday rescued four Spanish airmen, who, on an attempt to cross the Atlantic, had descended near the Azores, and for whose safety, after a week or more, during which no news was received from them, hopes had been all but abandoned.

Coal Mining Machinery.

A SPECIAL committee appointed by the Yorkshire coalowners to investigate the underground conveying and loading of coal by mechanical means has just issued its report. This report shows the increase in mechanical conveying during the past few years, and since the termination of Government control. It also shows the effect of mechanical appliances upon employment. In 1921 there were only 801 conveyors in use at the coal face in Great Britain, but by 1928 the number had increased to 2100. By what is known as intensive mining, in which the operations of cutting, shot firing, filling, ripping, packing, timbering, and moving forward the conveyor are performed in a definite sequence of operations, very remarkable increases in output have been obtained. One example given shows that the output per man per shift was increased from 1·9 to 4 tons. Other examples show that whereas by the old method of hand getting and hand filling into tubs, it took 82 man-shifts to produce 100 tons; with machine cutting and conveyor loading it only required 39 man-shifts to produce the same tonnage. In another case the number of men employed was reduced from 2400 with the old method to 1390 under the present system, for the same output. The effect upon the cost of the coal is, of course, very marked. These improved methods are not, however, applicable in all cases. Collieries have been visited where, owing to the quantity of dirt to be dealt with from the seam, and the extremely bad nature of the roof, intensive methods appear to be impracticable.

A New Continental Service.

ON July 1st the International Sleeping Car Company began a Pullman express service between Ostend and Cologne and in the reverse direction, on the same plan as that followed by the company in connection with the "Golden Arrow" and other express continental services. The new service has been rendered possible by co-operation between the Belgian National Railways and the German State Railways. It will include first and second-class Pullman coaches and will permit the journey between London—in co-operation with the Southern Railway—and Cologne to be completed in under twelve hours. In connection with the service the Belgian Government has placed orders for four new cross-Channel steamers, which, it is expected, will be in use on the Ostend-Dover route in 1930. An additional vessel for the same route and service will, it is understood, be provided by the Southern Railway. It may be recalled that on the "Golden Arrow" service between London and Paris the vessel employed is the Southern Railway's new turbine steamer "Canterbury," a Denny-built ship possessing some unique features.

Cairo Main Drainage Scheme—The Amiria Pumping Station.

THE main drainage works for any large city, especially if it be a congested one, always present interesting problems, not alone from the point of view of health, but from an engineering standpoint as well. Cairo is a city of the kind. It is divided into sixty-five areas, in each of which a system of pneumatic ejection is installed for forcing the storm water and sewage through cast iron pipes in the main collector at Ghamra. This main collector is constructed of cement concrete, and is approximately 14 kiloms. long. It starts at Ghamra and ends at Kafr el Gamous. The sewage gravitates to this latter station, where there are four sets of pumping engines dealing with the main flow and pumping it through a 36in. rising main to the purification works to Gebel Asfar sewage farm, 12 kiloms. away. It is worth recording that on this farm oranges are grown in great quantities.

The scheme was completed and put into operation in April, 1914, the works being designed for a considerable extension in the Cairo area. But it was found necessary in 1924 to consider alterations and extensions of the scheme, and three factors necessitated the construction of new Cairo Main Drainage Works. These factors are:—

(1) A more rapid increase in the population accompanied by a larger consumption of water than was anticipated in the original design. The latest census returns of the population of the city shows a figure of 1,060,597 in 1927, and upon this figure Cairo will hold a population of 1,195.400 in 1932, or 24·5 per cent. more than was anticipated in the original scheme.

(2) The subsequent inclusion of infiltration water as an anti-malarial measure; and

(3) The corrosion of the cement in the original main collector.

The third factor was a chemical problem. The original main collector is built of cement concrete, and was first used for sewage in 1914. A careful examination of the interior showed that the concrete had commenced to be eaten into by gases. Internal repairs or enlargement were out of the question, because of the amount of sewage and the asphyxiating nature of the gases, which rendered the employment of workmen inadvisable. Therefore it was definitely decided, after much thought, that the following new works should be considered:—

(1) Duplicate the rising main from Kafr El Gamous to Khanka.

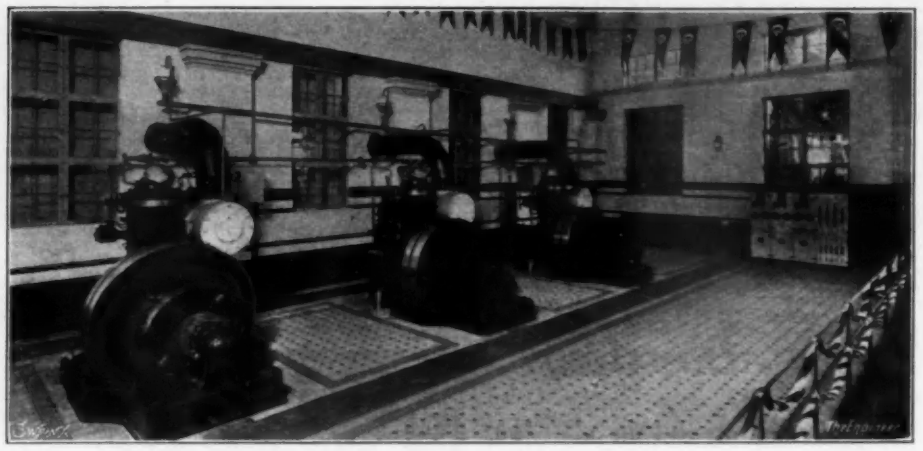
(2) Provide additional collector capacity.

(3) Divert the sewage in order to carry out internal repairs to the original collector.

(4) Increase the pumping machinery.

THE NEW PUMPING MACHINERY.

The whole of the pumping machinery, which was ultimately ordered, was designed and constructed by W. H. Allen, Sons and Co., Ltd., of Bedford, and their representatives, Messrs. Sayer and Colley, had charge of the contract. The machinery consists of four units, three precisely similar, namely, five-cylinder heavy oil engines, each direct coupled to four-stage "Conqueror" centrifugal pumps, and one smaller set for dealing with lighter duties, consisting of a three-cylinder engine with the same cylinder dimensions, driving through gearing a single-stage high-speed "Conqueror" centrifugal pump. Separate pumps are provided for cooling water for the engines, and filtered water for staff quarters. There is also an electrical installation with separate oil engines driving dynamos for supplying the power for the various motors for pumping work, for driving the workshops, and also for electric lighting, both inside and outside the building. The plant also contains a small workshop with various machines for making slight adjustments to the machinery when necessary. The engines are of the enclosed type, and the working parts are lubricated by means of oil under pressure flowing through all the bearings. They are capable of giving continuously 550 B.H.P. at 240 r.p.m. Each was subjected to very lengthy tests at the makers' works at Bedford in order to ascertain the B.H.P. and the consumption. They are fitted with heavy fly-wheels to ensure steady rotation.



OIL-ENGINE DRIVEN ELECTRIC GENERATOR SETS

In dealing with sewage and when large quantities of water and sometimes foreign matter have to be passed, it is essential that the areas through the pumps should be as large as possible, so as to prevent any choking, which would reduce the flow of the water. The impellers of the pumps are of cast steel and of the open, unshrouded type, running between renewable and adjustable side plates of cast steel. The pump shaft is of steel fitted with bronze sleeves. Special Michell thrust bearings are also fitted. The impellers and the shaft were very carefully balanced, so as to ensure freedom from vibration at the maximum speed, and it is very interesting to record that when running either one set or four sets independently or collectively, no vibration resulted. In the smaller set the engine develops 330 B.H.P. at 240 r.p.m. There are three cylinders of precisely the same bore and stroke as those of the large engines. This results in the advantage that any spare parts may be utilised for both sizes of engines. The centrifugal pump is driven through double helical gearing, giving a speed increase from 240 r.p.m. to 1175 r.p.m. The gears are made of steel and forced lubrication is fitted both to the gear wheels and to their bearings. The centrifugal pump is of the single-disc type and the design of the pump is similar in all respects to that of the four-stage pumps.

EXTERIOR OF ENGINE HOUSE. RECEPTION HALL IN BACKGROUND

WATER COOLING SYSTEM.

The cooling water system for the main engines is drawn from the canal some distance away from the engine-room, by two 4in. "Conqueror" centrifugal pumps mounted on the canal banks. These pumps are driven direct by electric motors. One of them is sufficient to supply the necessary cooling water, which is conveyed through a 6in. cast iron pipe to a settling tank adjacent to the engine-house. This tank is necessary, as the canal water, during certain seasons of the year, contains varying amounts of silt, which unless settled out would cause obstruction in the engine jackets. An open type cooling tower capable of dealing with the requisite quantity of water under the most trying conditions is included. The re-cooled water is led into the engine-room and delivered to the suctions of the motor-driven circulating water pumps, which are in duplicate.

For priming the four centrifugal pumps a motor-driven single stage horizontal vacuum pump, which is capable of priming one of the main pumps in a few minutes, is provided.

The auxiliary plant is in itself a small power-house. There are three elements, each consisting of a

INTERIOR OF RECEPTION HALL

50 B.H.P. single-cylinder oil engine of the vertical type, running at 275 r.p.m., coupled to a 31-kW continuous-current generator. Both the engines and generators are also of W. H. Allen, Sons and Co.'s make. An overhead hand crane of 10 tons capacity is provided. It commands the whole of the machinery in the building. Every care and attention has been given to dealing with the proper cleaning of the lubricating oil used, by mechanical means. All the four main pumps discharge into a rising main and the discharge is measured by a Venturi meter flow recorder and gauges. The whole plant is self-contained and can be started in a few minutes, and stopped in the same period.

The official trials took place during the first week in April, beginning on Monday morning, the 1st, and were completed on Saturday, the 6th. They were carried out by a number of independent engineers appointed by the Ministry of Public Works, and the results have now been tabulated. The guarantees of performance in the contract were very strict, but we are informed that the efficiency of the whole of the plant is higher than that guaranteed, and will effect a great saving in the cost of fuel to the Main Drainage Department.

The New and the Old.

As a matter of interest, within 300 m. of the site of Amiria Sewage Pumping Station is a steam station for irrigation, which was erected and set to work by the same firm for the Ministry of Public Works over twenty years ago.

Opening Ceremony by His Majesty the King.

Our readers, we feel sure, will be interested in the following account of the opening ceremony of the Amiria Pumping Station, which we have received from Mr. Richard Allen :—

"It is somewhat difficult to describe the Inauguration Ceremony, which took place on April 25th. One would want the pen of Robert Hichens to give true colour to the scene.

"Amiria is about 6 miles out of Cairo, north-east, situated on the Ismailia Canal, surrounded by cultivation, corn and greenstuff, irrigated by our old steam pumping station, now twenty-two years old.

"The day of the opening was extremely hot, 96 deg. Fah. Two large temporary buildings were erected, one adjacent to the engine house, 'The Reception Hall,' where the ceremony took place, the other in the gardens used as Refreshment House, divided by a partition for the King and a few selected people with green tickets, and the other part of the hall for invited guests with red tickets. The Reception Hall was furnished with 800 golden chairs facing each other, with a raised dais for the King with only one huge golden chair, and alongside a table for the golden lever which was connected by wire to one of the air levers on the first Diesel engine. Also on the table was a dial recorder and a standard electric light.

"A new road, about one mile long, at right angles to the Canal, and joining the main road near His Majesty's Palace, had been specially made for the occasion. It was beautifully decorated with flags, banners, and triumphal arches, and guarded by troops and police, and with the people lined up on both sides was a wonderful sight.

"Both inside and outside the Reception Hall it was a scene of great brilliance, with the King's Bodyguard, one Regiment of Egyptian Infantry, two bands, triumphal arches, and thousands of flags.

"The company commenced to arrive at 3.30 by cars, and by 4.20 everything was in readiness ; at 4.25 the High Commissioner arrived in State with outriders. The Prime Minister, Past Prime Minister and all the Ministers of State with their Under-Secretaries, Diplomatic Corps, Representatives of the British Army, and Air Force had taken their places.

"Everything was now in readiness, and first you could hear a subdued hum of conversation, then the cheering outside. All the Ministers left their places and walked down the Hall to receive his Majesty. Then came the general Salute, whilst the Egyptian National Anthem was played by the band, and the King proceeded up the Hall acknowledging the silent salaams.

"The Minister of Public Works delivered an oration, giving a survey of the scheme, and the necessity for the new pumping station and pipe line.

"At the conclusion the Minister stepped forward and explained the working of the golden lever to the King, who then operated it. The doors of the engine-house were opened, 10,000 lights turned on, the Diesel engines started like magic, and the recording dial hand commenced to work, showing the station was alive.

"The King, with the High Commissioner, Prime Minister, and other Ministers and staff, then proceeded to inspect the engine-house, where the whole of the machinery was in operation and the four sets of Diesel engines and pumps were working silently. The King and all the Ministers were highly delighted at the success of the Official Opening."

Amongst the views which we give, one of the Reception Hall is reproduced, as engineers will be interested in seeing the state which attends the Royal openings of their works in Egypt. Other views, on page 15, show the main pumping engine-house from different aspects, and yet others on the preceding page the exterior of the engine-house and the auxiliary plant ; whilst plans of the station as a whole are reproduced in a Supplement to this issue.

Institution of Mechanical Engineers.

No. II.*

SUMMER MEETING.

On Thursday, June 27th, the members and their friends taking part in the Summer Meeting of the Institution of Mechanical Engineers at Manchester continued their visits to works in the district, in accordance with the attractive programme which the local Reception Committee had prepared. In the evening a reception, concert, and dance were held in the College of Technology, the guests being received by the Lord Mayor of Manchester and the Lady Mayoress and by Mr. and Mrs. H. L. Guy.

On Friday, June 28th, while some members continued the programme of visits to works, many others proceeded either to Chester or to the Peak District on whole-day excursions. The weather, as it had done throughout the whole of the meeting, co-operated most commendably with the painstaking and successful efforts of the Reception Committee to make both these excursions pleasant and enjoyable. The last event on the programme was a reception at the Victoria University, Manchester, on Friday evening. The guests were received by the chairman of the University Council and Mrs. Worthington and by the Vice-Chancellor and Mrs. Moberly. During the evening the degree of Doctor of Science (*Honoris Causa*) was conferred by the Vice-Chancellor on the President, Mr. Daniel Adamson, and on Sir Henry Fowler, past-President.

We give below some notes on the works visited by the members on the last two days of the meeting.

Crossley Brothers, Openshaw.

The firm was founded in 1866 by the brothers Francis William and William John Crossley, trading as Crossley Brothers. In 1897, on the death of the senior partner, the business was made into a limited liability company under the chairmanship of Sir William J. Crossley, Bart. Shortly before his death in 1911, his eldest son, Sir Kenneth J. Crossley, Bart., was appointed chairman, which position he still holds. The firm was the pioneer of the internal combustion engine, having built and developed the original Otto and Langen gas engine. More than 100,000 oil and gas engines have now been built by the company, and it is of interest to note that there are examples of engines still at work, or available for use as standby, which were constructed fifty years ago.

The head works at Openshaw are now devoted solely to the building of horizontal and vertical engines for industrial and electric lighting purposes in powers ranging from 20 to 330 B.H.P. They include large foundries, machine, erecting and testing shops and laboratories. For the past ten years the principal product of the works has been heavy oil engines, although a large number of gas and convertible engines —oil and gas—have been built to operate upon various kinds of fuel.

The other establishments of the company are Erwood Park Works at Heaton Chapel and Sandiacre Works near Nottingham. The former were established in 1915 to deal with war work, and are now exclusively devoted to the manufacture of suction and pressure gas plants and of small engines. The Sandiacre Works were acquired in 1919 from the Premier Gas Engine Company and the building of large gas engines of up to 1000 B.H.P. has continued. A fourth factory, at Bedford, is exclusively engaged on building small electric lighting sets, agricultural engines and pumps, and tractors.

Crossley Motors, Gorton.

This firm is an offshoot of Crossley Brothers, and specialises in the manufacture of pleasure and commercial vehicles. The works occupy an area of 10 acres and employ some 2000 men. Besides the manufacture of chassis, the firm builds all the coach-work required for the various classes of vehicles produced. Two types of pleasure car and three types of passenger chassis are manufactured. In addition, a variety of vehicles is made for British and foreign Governments, including six-wheelers, armoured cars, Kegresse vehicles, &c.

Mirrlees, Bickerton and Day, Hazel-grove, Stockport.

In 1897 the Mirrlees Watson Company of Glasgow built the first Diesel oil engine made in Britain, and it is believed that this engine was the third of that type built anywhere. After a few years of experimental work the manufacture of such engines reached the commercial stage, and by 1908 the department had grown to such an extent that limitations of space in the original factory resulted in the decision to build new and specially equipped works. For financial reasons, a separate company was formed, and a large site, recently extended to nearly 300 acres, acquired near the boundary of the Borough of Stockport. The area at present occupied by the works is 9 acres. The engines built range from 25 to 1000 B.H.P., operating on the four-stroke cycle, and from 40 to 2000 B.H.P. operating on the two-stroke cycle.

The heavy machine shop is 325ft. long by 50ft. span, and is parallel to and of the same size as the testing department. The medium and small machine shops are bays of 25ft. span, having saw tooth roofs. The packing shop is entirely separated from the main shops to reduce fire risks, and to enable finished engines to be removed from the main works. There are comprehensive stores for raw material and finished parts. The firm generates its own electrical energy, all machine tools being driven electrically either individually or in groups. In the laboratory metallurgical problems, and those relating to fuel and lubricating oils, are dealt with. The company owns two foundries and has a large interest in a third, but these establishments are quite separate from the main works.

The company has recently taken up the "nitralloy" process of case-hardening steel and employs Mr. E. G. Herbert's "Cloudburst" method of testing hardened surfaces and of giving such surfaces additional hardness. Both these processes were demonstrated to the visitors.

The National Gas Engine Company, Ashton-under-Lyne.

The company was formed in 1889 by Mr. H. N. Bickerton, M.I. Mech. E., and has developed into one of the largest concerns in the world devoted to the manufacture of internal combustion engines and suction gas plants. The works cover over 30 acres, and are divided into a series of twenty large bays. The ironfoundry is capable of an output of 200 tons per week, including castings up to 20 tons in one piece. It is equipped with modern cranes, moulding machines, sand blast and sand handling plant, &c. Separate shops are devoted to the manufacture of bronze and brass castings and to white metalling and case-hardening. The machine shops, which occupy seven bays, are equipped with up-to-date machine tools, many being specially designed for the company's particular requirements. As far as possible, all parts move forward continuously from the foundry or stores to the erecting shop. Engines are erected and tested in the bays adjoining the machine shops. A special department deals with the supply of renewals and spare parts. Practically all the machinery is electrically driven, the supply being taken from the power station at each end of the works. The generators in the two stations are driven by oil and gas engines of various designs of the company's manufacture. Gas is supplied from a 3000 H.P. Mond gas plant fitted with ammonia recovery, tar dehydrating oil and recovery plants, which considerably reduce the cost of the gas.

Following the visits to the works of Mirrlees, Bickerton and Day and the National Gas Engine Company, those taking part in them proceeded to Thornycroft Hall, Siddington, where they were received by Mrs. H. N. Bickerton and were entertained to tea.

L.M.S. Railway Company, Carriage and Wagon Works, Newton Heath.

These works were opened in 1877 for the manufacture of carriages and wagons for the Lancashire and Yorkshire Railway Company, additions being made to the original building in 1896 and in 1914. The area of the works at present is 45 acres with a total shop area of 14 acres, the length of sidings being over 13 miles.

The carriage repair shop was built in 1914 and covers an area of 126,808 square feet. It is equipped with one 20-ton and four 10-ton cranes. The carriages are brought into the shop by means of a 40-ton traverser and the repairs are carried out under a progressive system. After the trimmings have been removed, the carriages are lifted from their bogies in the lifting bays on to movable trestles, on which both carriage and bogie progress down their respective roads simultaneously, being propelled at a constant speed by mechanical power. After leaving the lifting bays the carriage is taken through the body repair and finishing stages, so that by the time the vehicle is ready to leave the shop the trimmings and inside fitments have been replaced, and the vehicle is ready for the paint shop.

Timber enters the saw mill as rough scantling at one end of the building and emerges at the other in a finished state ready for the building shops. The mill is laid out in two sections, one for dealing with carriage pillars, and the other for dealing with wagon scantlings, coach bottom sides and cant rails. The machines are arranged in sequence of operations, and all machining is done to limit gauges, no hand labour being necessary on the completion of the operations.

The progressive system of working is also employed in the body shop. The doors, ends, and quarters are built in jigs, compressed air being utilised for driving home the tenons, and pneumatic screw driving machines for fixing the screws. The floor of the coach is built on the underframe, and afterwards the whole of the sections are assembled thereon. On the completion of this stage the vehicle moves forward at stated intervals until completion ; the first coat of paint is applied before the vehicle goes into the paint shop. A portion of the body shop has been partitioned off for the coach finishers, the polishing room being adjacent. The various fluids are applied where possible by means of a spray.

Three shops are provided for the building and repairing of wagons and the work is carried on under a progressive system. The timbers are supplied to size and no hand work except on assembling is

* No. I. appeared June 28th.

necessary. All materials are delivered at the correct height as the vehicle progresses towards completion.

L.M.S. RAILWAY COMPANY, LOCOMOTIVE WORKS, CREWE.

These works provide for the manufacture and maintenance of locomotives of the Western Division—formerly the London and North-Western Railway. They were originally constructed in 1843, and have recently been thoroughly reorganised.* The principal items of interest are:—The new boiler-building department, capable of an output of seven boilers weekly; the new steel works, comprising two 45-ton acid and two 75-ton basic steel furnaces; the forge and rolling mills for the production of tires, axles, and forgings; the heavy machine shop, which contains a large number of modern machines for the production of locomotive cylinders, frames, and other heavy components; and the new erecting shop, which is capable of accommodating sixty-six locomotives. In the last-named shop all engines are repaired under a progressive system, whereby the engine is moved from stage to stage as the various parts of the work are completed. A section of this shop is devoted to the building of new engines, its capacity being approximately 100 locomotives annually.

THE PARTINGTON STEEL AND IRON COMPANY, IRLAM.

The coke oven plant at these works at present comprises a battery of sixty-two coke ovens, a coal-washing, and a by-product plant, capable of dealing with 1900 tons of coke per week. Coal, in the form of slack, is automatically handled from the truck to the coal washery, and after washing is elevated to storage bunkers, whence it is taken to the ovens for coking. The ovens are fed by a charging machine, and after the process is completed, the coke is ejected by an electric ram, being quenched during the operation, on to a sloping hearth. It is then directly loaded into special skips, weighed, and recorded, prior to being conveyed to the blast-furnaces. The surplus gas produced is used for firing boilers and heating the active metal mixer in the open-hearth steel plant. The by-products consist of sulphate of ammonia, whizzed naphthalene salts, heavy naphtha, crude tar, refined tar, pitch, crude benzol, and motor benzol ("Partene").

The blast-furnace plant consists of six furnaces, each furnace being capable of an output of upwards of 1500 tons of iron per week. Storage bunkers are provided for the reception of the raw material prior to its being charged into the furnaces by means of a mechanical hoist, which elevates the charge in 5-ton skips. The waste gas from the furnaces is used in a variety of ways, namely, firing boilers for steam-raising purposes, driving the gas engines in the main power-house, and heating the Cowper stoves.

The steel melting shop is at present capable of producing 3600 tons of steel per week by means of Siemens open-hearth regenerative furnaces. The molten metal is taken from the blast-furnaces by means of hot metal ladles to the active metal mixer, in which the silicon and sulphur are reduced. The mixer has a capacity of 250 tons. The molten metal is then transferred from the mixer to the open-hearth furnace, where it is converted into steel.

The ingots for the rolling mills are taken from the melting shop to the soaking pits, preparatory to cogging. The soaking pits are four in number, and have a capacity for ninety-six ingots. The cogging mill is 40in. between centres, electrically driven by an Ilgner set. The normal rating of the motor is 5000 H.P., but it is capable of withstanding peak loads up to 16,000 H.P. This mill is capable of rolling 5500 tons of ingots per week, and the resulting blooms are dealt with in the large and small mills. The mill also contains a bloom shears, cutting 16in. by 13in. hot blooms. The roughing and finishing mills are 28in. between centres. The material is conveyed from the cogging to the roughing, and from the roughing to the finishing mills by means of live rollers. Two 5ft. pendulum hot saws and hot finishing and rail banks are provided. The small mill contains one stand with a 20in. housing, and three stands with 18in. housings, capable of rolling light rails and small general sections.

The foundry is divided longitudinally into two bays, and is equipped with four overhead travelling cranes. There are three cupolas, one of 10 tons, one of 5 tons, and one of 30-cwt. capacity. The equipment also includes three Tropenas steel converters, one of 2 tons and two of 1-ton capacity each. The shop is capable of dealing with steel castings up to 3 tons in weight, and iron castings up to 8 tons, and the weekly capacity is 110 tons of iron castings, 10 tons of steel castings, and 3½ tons of brass and copper castings.

The power used in the various departments is supplied from the power-house, situated centrally in the works, and containing one 3000-kW gas engine generator, six 1000-kW gas engine generators, two 1000-kW turbo-generators, four turbo-blowers, and three gas engine blowers. The efficiency of the plant will shortly be raised by the provision of waste heat boilers.

THE SALT UNION'S MEADOW BANK MINE, WINSFORD.

With a single exception, this is the only salt mine now in operation in Great Britain. It was originally sunk by the late Mr. H. E. Falk about 1852. It was closed down in 1890 as the Adelaide Mine at Northwich was then being worked, but on the failure of the shafts of the latter in March, 1928, the Meadow Bank Mine was reopened, and full advantage taken to install modern equipment. The mine, which is situated in the heart of Cheshire, between Winsford and Whitegate, is 460ft. deep, and covers an area of nearly 13 acres. The methods employed in mining salt are quite different from those of the coal industry. Salt is excavated to a thickness of about 20ft. over a wide area, large square pillars being left at suitable intervals to support the roof. The winding gear is electrical, with overwind control in duplicate. The shafts are 3ft. 6in. square and are served in the usual way by cages for trucks and passengers. The underground equipment consists of an electric locomotive for traction purposes, and an electrically-operated Sullivan undercutter with pneumatic drills. The mine is electrically lighted throughout.

The surface equipment comprises a complete crushing, grinding, and grading apparatus, rock salt being required in many forms from large lumps down to finely ground salt, of which there are seven grades. An ample siding grid and a rubber conveyer to the bank of the river Weaver complete the transport arrangements.

LINOTYPE AND MACHINERY COMPANY, ALTRINCHAM.

The company's estate covers about 60 acres, of which about 12½ acres are occupied by the works buildings and offices. The buildings comprise the offices, a drawing-office, the main machine shop, the foundries, erecting shops, pattern shop and stores, boiler and engine-house, &c., and with the exception of the offices and a new storage building, are all on one floor with top lighting. The main shop containing the ordinary machine departments—planing, milling, turning, &c.—cover 3 acres under one roof, and also houses the departments containing the special tools for the manufacture of matrices, moulds, and magazines for the Linotype machines.

The works are self-contained and self-supporting. With the exception of some small parts, mainly involving rubber products, the company's machines are entirely produced at the works, in which every process is carried out from the original castings to final electro-plating, where necessary.

The main foundry contains four cupolas and the necessary core ovens. The plate moulding shop is equipped with two furnaces, a pneumatic moulding machine, hand turnover moulding machines, and electric mould driers. Adjacent is the fettling shop, equipped with an air compressor for sand blasting, also a cleaning room, sand-blast tumblers, and emery wheel grinders. The smithy includes eight hearths and two pneumatic hammers.

In the capstan and automatic departments there are sixty machines, comprising capstan, turret, and automatic lathes. The gear-cutting department has an equipment of twenty-six machines, consisting of spur, spiral, bevel, and worm gear cutting machines, also rack-cutting and broaching machines. In one portion of the general stores building there is a large battery of automatic stamping and blocking presses, which produce small parts punched from metal strip.

The standard of accuracy is kept very high, and in certain departments the margin of error allowed is only one-fourth of 1/1000in. The patterns and punches for the manufacture of matrices are produced by a series of machines specially invented for the purpose and manufactured by the company. On an average a stock of over 25 million matrices is kept at the works, and is continually being added to.

All the offices and departments, managers and foremen are linked together by an automatic telephone of 100 numbers. There are at present about 2000 persons employed in the works, and there are on the estate 222 houses mainly occupied by the company's employees. There is also a guest house standing in its own grounds.

THE BUDENBERG GAUGE COMPANY, ALTRINCHAM.

The present works were erected in 1913 and 1914, and comprise a two-storey fireproof building accommodating the offices, store-rooms, laboratory, and test-room. At the rear of the main building is the engineering shed, which covers 18,000 square feet. The works are principally devoted to the manufacture of all types of pressure gauges; also dial thermometers of both the steel tube mercury and the vapour tension types for industrial purposes; tachometers for turbines and other machinery; automatic recording instruments for temperature, pressure, and speed; mercury columns; depth gauges; gauge testing apparatus and kindred instruments. The equipment comprises modern machinery for the large-scale production of instrument parts finished to a high degree of accuracy, and consequently embodies many complete series of press tools and jigs. The testing apparatus includes a 55ft. high mercury column for pressures up to 300 lb. per square inch, with full error corrections. For higher pressures deadweight testers of both the differential and the single-piston types are employed. A deadweight tester for the accurate measurement of pressures up to 32 tons per square inch was recently made and another for use up to 40 tons per square inch is in course of construction. The piston for the latter instrument has been certified by the National Physical Laboratory as having a mean diameter within 0·00001in. of nominal, and to be straight and truly cylindrical within 0·00002in. The weights are accurate to within ± 0·5 grain. In the test-room there are pumps capable of producing violent pulsations in pressure, which are used for testing gauge tubes and working parts for durability under severe conditions, and for the determination of the best materials and design.

THE MERSEY TUNNEL, BIRKENHEAD.

The Mersey Tunnel for vehicular traffic connects Liverpool and Birkenhead and forms a link not only between these two towns, but also between the general highway systems which are severed at present by the river Mersey. Plans for improving the communications between the two towns and counties have been under consideration for more than three-quarters of a century, and bridges as well as tunnels have been proposed. In June, 1922, a Committee, known as the Mersey Co-ordination Committee, under the chairmanship of the late Sir Archibald Salvidge, instructed Sir Maurice Fitzmaurice, Mr. Basil Mott, and Mr. John A. Brodie, the City Engineer of Liverpool, to make a report on the provision of a bridge across or a tunnel under the Mersey, with a view to improving the facilities for cross-river traffic. After a study of all the elements of the problem, the engineers reached the unanimous conclusion that a tunnel would best meet the requirements.

The plans were made and deposited with Parliament, and authority given by the Mersey Tunnel Act of 1925 for the construction of the tunnel and the setting up of a statutory committee to carry out the powers conferred by the Act. The Committee consists of ten members appointed by the Liverpool Corporation and seven by the Birkenhead Corporation. The first Chairman was Sir Archibald Salvidge, to whose public-spirited energy the genesis of the project was greatly due. He held office until his death in December, 1928. The present Chairman is Sir Thomas White. Further detailed study led to modifications in the plan from the original scheme. These modifications were authorised by the Mersey Tunnel Acts of 1927 and 1928 respectively.

The tunnel plans are now as follows, beginning at Liverpool and going towards Birkenhead. The through traffic entrance is at Old Haymarket, where the tunnel descends at a gradient of 1 in 30. The dockside entrance is at New Quay, just north of Chapel-street, and the tunnel descends at the same gradient. The two branches come together under Dale-street, near North John-street, and the tunnel continues as a single structure across Castle-street, down Brunswick-street, and under the river. The gradient of 1 in 30 continues to a point 779ft. beyond the quay wall of George's-parade, Liverpool. The tunnel then rises slowly for 1670ft. to a point 1299ft. from the Birkenhead Quay wall, where the gradient again becomes 1 in 30, and the tunnel continues as a single structure to a point in Birkenhead in the block bounded by Canning-street, Bridge-street, and Argyle-street. From this point the two approach tunnels diverge. The through traffic line curves under Hamilton-square, Hamilton-street, and comes to the surface at the junction of Chester-street and Market Place South. The gradient of this approach is 1 in 30, and the entrance is close to the main highway, Chester-street, and at a focal point for the convergence and divergence of the through traffic.

The dockside branch has a ruling gradient of 1 in 30, with 1 in 40 for part of its length, and passes parallel to Cleveland-street, to an entrance at Rendel-street, near Corporation-road. The width of the roadway between kerbs, from the Old Haymarket, Liverpool, to Market-place South, Birkenhead, will be 36ft., and enough for four lines of traffic abreast. The width of the roadway on each of the dockside branches will be 19ft., sufficient for two lines of traffic. The total length from end to end of the through traffic line will be 2·16 miles and of the dockside line 2·08 miles.

The under-river portion of the tunnel, 46ft. 3in. external diameter and 44ft. internal diameter, will be the largest subaqueous tunnel yet constructed. The total length of tunnel will be 2·9 miles. The quantity of excavation will amount to more than 1,000,000 tons of rock. The tunnel will be lined with cast iron plates bolted together, to support the ground and to afford a lining which is perfectly water-tight. The total weight of iron thus used will be over 75,000 tons. The iron lining will be protected from corrosion by an outside and inside covering of cement grout and concrete.

The first contract for the work was known as Contract No. 1, and was awarded by the Joint Committee on December 8th, 1925, to Edmund Nuttall, Sons and Co., of Trafford Park, Manchester. The work was formally inaugurated in December, 1925, when H.R.H. Princess Mary turned compressed air into the drills at the working shaft at George's Dock, Liverpool. This contract was for the purpose of driving preliminary tunnels along the line of the future main tunnel in order to explore and prepare the ground prior to the execution of the full-size tunnel work.

On April 3rd, 1928, the heading from Liverpool met that from Birkenhead almost exactly under the middle of the river, and the occasion was marked by a ceremony, in which the Chairman of the Mersey

* A paper read before the Institution by Captain H. P. M. Beames, on "The Reorganisation of Crewe Locomotive Works," was reprinted in our issue of March 23rd, 1928.

Tunnel Joint Committee broke through the wall of rock separating the two headings. The headings met to within an inch both for line and level. Following the completion of the first contract, the Joint Committee awarded to Messrs. Nuttall, the contract, known as Contract No. 2, for the enlargement of the preliminary tunnels across the river between George's Dock, Liverpool, and the Morpeth Branch Dock, Birkenhead. Work is now in active progress under this contract, and the full-size tunnel is being constructed from ten different points under the river. Contract No. 3 comprises the construction of the full-size tunnels in Birkenhead. On November 14th, 1928, this contract was awarded to Sir Robert McAlpine and Sons, of London, who are now at work. Contract No. 4 included the construction of the full-size tunnels at Liverpool. On March 20th, 1929, the Joint Committee awarded this contract to Messrs. Nuttall. The work under the latter two contracts is now being started, and there are some 900 men at work, but when work under all the contracts is in full operation this number will be doubled.

It is hoped that the tunnel will be available for use in three years' time. The cost will be £5,222,000, of which one-half will be contributed by the Ministry of Transport and the other half as to one moiety by tolls and as to the other moiety by Liverpool and Birkenhead Corporations.

(To be continued.)

Steel Trade Conditions: British and Foreign.

By E. T. GOOD.

ECONOMIES at home and rising costs abroad have combined to change the international iron and steel trade competition. Our position has been greatly strengthened. We have still much capacity idle, and many firms making losses or inadequate profits, and there is some danger of our trade revival movement being turned once more into decline or slump by costly fuel; but at the moment conditions are much in our favour. Since early in 1926 the cost of our coal has declined by 3s. 6d. a ton, which means anything from 7s. to 12s. a ton off the cost of steel, according to the degree of manufacture or finish. We have also had substantial mechanical improvements in our works. The net result is that in recent months the average level of our iron and steel prices has been only about 13 per cent. above pre-war, compared with a general commodity price index about 40 per cent. higher than before the war. Foreign iron and steel prices are all much more advanced than ours, as compared with 1913. To take an extreme case, we have British ship plates as cheap as before the war, compared with American plates about 75 per cent. dearer. German iron and steel prices range from 15 to 33 per cent. higher than in 1913, and only by extremely lavish bounties and rebates operated through syndicates and at the expense of home consumers, can German steel compete successfully in neutral markets. Since 1923 German miners have had at least nine wage advances; "rationalisation" has failed to effect economies; and furnace coke has been from 3s. to 5s. a ton dearer at German iron and steel works than coke at our works.

Our chief competitors since the war have been the French and Belgians. Their costs have seriously increased owing to higher wages and fuel and general costs, with this result :—

French and Belgian Steel Export Prices, Per Ton, at Antwerp.

	A year ago.	Now.
Blooms	81s. to 86s. ..	94s. to 99s.
Billets	88s. to 92s. ..	104s. to 107s. 6d.
Sheet bars ..	92s. to 94s. ..	107s. 6d. to 108s.
Merchant bars ..	105s. to 106s. ..	118s. 0d. to 119s. 0d.

In these circumstances we have been able to increase production, reduce imports, and use far more home-made steel. Here is the output record :—

British Production of Steel in Tons.

1913 monthly average	638,000
1929 average for first five months	810,000

With imports slightly higher and exports slightly lower, in recent months than before the war, we have an even greater consumption of material in our finishing shops than the output figures reveal. Import and export figures are not well understood. The bare tonnage returns are apt to mislead, though they are perfectly correct, as follows :—

Iron and Steel and Manufactures Thereof, in Tons (Exclusive of Engineering Goods).

	British exports. Tons.		Imports. Tons.
1913	4,969,200	.. ..	2,230,800
1927	4,200,000	.. ..	4,406,400
1928	4,321,200	.. ..	2,895,000
1929 (first five months) ..	1,933,900	.. ..	1,105,500
1928 (first five months) ..	1,761,800	.. ..	1,331,800
Increase	172,100	Decrease	226,300

But the tonnage figures do not tell the whole story. Whereas our imports average less than £9 value per ton, our exports are worth an average of more than £15 per ton. Actually, our exports in the first five months of this year have been worth £29,300,600, whilst our imports have only been valued at £9,882,100. Whereas we heavily import crude and semi-materials of comparatively low value, our biggest export line in tonnage is the galvanised steel sheet, worth about £15 a ton, and our second largest export tonnage is in tin-plate, worth nearly £20 a ton. Though Germany, France and Belgium often beat us in export tonnage, we are always on top in value, except when we have a big mining stoppage. Twenty and more years ago we exported over 1,000,000 tons of pig iron annually—a low-priced raw material for foundries and steel works. Now we export less than half that tonnage of pig iron; but our exports of galvanised steel sheets and some other high-priced products have doubled, trebled, and even quadrupled since the early years of the present century. On an iron and steel tonnage basis we are doing a much smaller share of the world's trade, but in value we continue to do at least fairly well.

There is one big factor in our favour which needs to be observed when we are hearing so much about the factors against us. Frequently our trade has been set back by strikes; invariably we have to pay higher wages and local rates than our continental competitors; and our fiscal system does not seek to reserve our home market for our own goods. But in convenience and cheapness of transport for heavy materials—ore, coal, pig iron and steel—we are favoured above all our rivals. There is a common idea that we are handicapped by high railway charges. No idea could be more mistaken. In some foreign countries they have their works near iron ore mines. In some they have works near coal mines. In no foreign country have they ore and coal and works all close together, as we have. Again, no foreign country has either coal mines or iron and steel works near ports. We have. As regards imported ore we have some of our blast-furnaces so situated that the ships can land the material right alongside the stacks, and we have coal pits and coke ovens practically at the back doors of our works. We have such a combination of geographical advantages—such short and cheap hauls by rail plus such shipping facilities—that a ton of British steel can be delivered in Canada for a much less inclusive transport cost than a ton of American steel can be delivered in that Dominion bordering on the United States. It costs more to assemble the materials to make a ton of pig iron in America than it costs us to assemble our materials for the iron and the steel, and then to carry the steel products to a port. Again, the ocean freight from Britain to Canada is much lower than the overland rail rates between American works and Canadian cities. In Germany the average haul for raw materials to works and finished products to ports is about 150 miles. In France it is about 200 miles. In our country it is under 30 miles. Even in tiny Belgium the works are so situated that imported ore has to travel about 80 miles from the seaboard to the furnaces, and the finished steel for export has to travel the same distance to the docks, with the result that we hold a transport cost advantage over the Belgians. Over the Germans, the French and the Americans our advantage is very great.

The cheap labour, or cheap production advantage, held by the continentals over us has much diminished in the last year or two, as indicated by the figures given above. British shipbuilders are not importing big tonnages of foreign plates to-day because of cheapness. The cheapness has disappeared. In other lines it has lessened. Our people have better chances than for many years past of increasing their export trade and of retaining more of the home trade. But if by any measure or method our fuel is seriously increased in price our steel trade will be plunged into severe depression.

Canadian Engineering News.

(From our own Correspondent.)

Telephoning From Moving Trains.

COMPLETE telephonic conversation was maintained for two hours recently between a moving train on the Allandale Division of the Canadian National Railways and the telegraph head offices of the system in Toronto. Passengers on board moving trains with this equipment may reach any point served by the ordinary telephone system; similarly passengers on these trains may be communicated with by telephone from any point reached by local or long distance telephone. By the new system communication is provided between a telephone set on a moving train with a telephone operator in charge and another telephone set in a terminus on the railway right of way, adjacent to the telegraph lines. This is made possible by an aerial on the roof of the car from which the voice jumps to the telegraph lines parallel to the railway tracks. The terminal station is equipped with a switchboard through which connection is made with the regular telephone system. The first installation of this equipment in Canada will probably be between Toronto and Montreal. Work is proceeding towards equipping a number of the more important trains between these two cities and should be completed in the course of a few months.

A New Copper Refinery.

Plans are understood to have been completed by Noranda Mines, Ltd., for the establishment of a copper refinery, to be built on tide water, probably the St. Lawrence River. Noranda is associated in this enterprise with the British Metals Corporation, of London, England, and the Nichols Copper Company, of New York. With reference to the proposed refinery, President James Y. Murdoch, of Noranda, stated, at the annual meeting, that engineers of the company were investigating the economic problems involved, but beyond a decision that the plant would be built on tide water, no announcement as to its definite position was possible at the time.

New Method for Refining Nickel.

A proposed new method for the refining of nickel, which uses no chemicals and has a very low cost of operation, was outlined at the recent Dominion Chemical Convention in Toronto, by F. E. Lathe, technical assistant to the President of the National Research Council of Canada. Present methods, Mr. Lathe said, are ingenious and have been developed to a high state of efficiency. They have, however, one common weakness, that the first and principal step in the separation of nickel and copper is only a partial one, some of the copper accompanying the nickel and some of the nickel accompanying the greater part of the copper.

The refining method suggested is based upon a principle well known in analytical chemistry, that copper and all the precious metals associated with nickel can be precipitated as sulphides in acid solution, but neither nickel nor cobalt can be. Mr. Lathe told the Canadian chemists that two methods which could be used either singly or in combination had now been discovered of achieving this. Both, he explained, were highly technical, but, in brief, the first consisted of keeping the nickel as sulphide in the matte; this is, by stopping the converted blow while there was still sufficient sulphur in the matte to combine with all the nickel and copper. The second was to cool the molten matte as swiftly as possible to prevent the formation of large crystals, for which a convenient method was granulation in water. Coming to the crux of his address, Mr. Lathe said that the method he had just outlined made it possible to secure, within a reasonable time, a solution containing 99 per cent. of the nickel and cobalt without any trace whatever of the copper and other precious metals which had given the metallurgists so much worry.

Another Big Hydro Project in Western Canada.

The North-Western Power Company, Ltd., a subsidiary of the Winnipeg Electric Company, has commenced operations on the construction of a hydro-electric development at Seven Sisters Falls on the Winnipeg River, which will mean an additional 225,000 horse-power for the Province of Manitoba. Progress to date has included the clearing of the site, construction of a thirteen mile standard gauge railway between the Canadian Pacific main line at Whitemouth and Seven Sisters Falls; the building of a 7½ mile transmission line connecting the site with the trunk line between the Winnipeg Electric Company's Pinawa power plant and the City of Winnipeg; the erection of a sub-station for power distribution to the construction work; the formation of a camp, and the building of a town for the permanent staff. The lay-out of the development in general comprises a power-house and dam built directly across the Winnipeg River, which will back up the head water about 50ft. and submerge the cascades above, forming a large storage reservoir. This raising of the water to a height above the adjacent banks will necessitate the construction of dykes extending a distance of approximately four miles on each side of the river upstream above the dam. The position of the power-house has been fixed by the local topography at a point nearly 4000ft. upstream from the foot of the last falls, so that it is necessary to excavate a tailrace for that distance to obtain the maximum available head. The ultimate installation of the plant will comprise six units each of 37,500 horse-power, the overall available head being 66ft. The speed of the units will be 138·5 r.p.m., and the generated voltage will be stepped up to 110,000 volts for transmission to the Winnipeg Electric Company's distribution system in Winnipeg.

Montreal Terminus Project.

The Canadian National Railways have completed plans for the construction of new terminal facilities in Montreal which will involve an expenditure of approximately 50,000,000 dollars, and which will result in the complete transformation of the central portion of the city. While the new central station to be built will be underground, the skyline will be altered through great buildings which will be erected overhead. Dominating the picture of the new down-town area will be the Canadian National headquarters, a huge structure in which will be concentrated the offices of the railway now scattered in fourteen different buildings throughout the city. One of the most remarkable features of the scheme is that there will be available in the heart of Montreal, leasehold property for the erection of superior office buildings, hotels, shops and other structures, covering an area of 600,000 square feet. Some indication of the magnitude of the task to be undertaken is gleaned from the statement that the plans include, in addition to the creation of a large modern central station, co-ordination of railway facilities, economies in operation, extension of freight accommodation, and the solution of a serious problem by the elimination of level crossings, the last mentioned item accounting for fully one-third of the estimated cost of the undertaking. Provision is also made for the construction of 17¼ miles of new railway, which are necessary to connect existing lines in the process of co-ordination. New streets running through or over the new station will be provided. Provision for increased vehicular traffic is included in the plan, and a special feature will be a double tube subway for vehicles under one of the streets near the station, designed to prevent congestion and delay to vehicles.

PROVISIONAL arrangements have been made by the Leeds and Bradford Corporations for the joint establishment of a municipal aerodrome equidistant from both cities. It will probably be established at Yeadon.

Locomotive Performance.

By E. C. POULTNEY, O.B.E.

No. I.

Dynamometer Records.

Previous articles have dealt with the boiler and cylinder performance of two express locomotives tested on the locomotive testing plant by the Pennsylvania Railway system at the Juniata shops, Altoona, Pa.* The two locomotives forming the subject of these trials and of the present articles are the "Pacific" type passenger engine "No. 877," Class "K 2 s.a.," and the "Atlantic" engine, "No. 89," "Class E 6 s."

In discussing the performance of the complete locomotive, the combined efficiency of the unit as a whole is taken into consideration, and in order to determine the power and the efficiency obtained at the draw bar, it may be convenient to consider first the mechanical efficiency or the power absorbed by the engine in operating its moving parts, and the relationship which this machine-friction bears to the total power developed under any set of running conditions.

Mechanical Efficiency.

The mechanical efficiency per cent. is given by Fig. 1, plotted against speed in revolutions per minute. The length of the stroke being the same, and the diameter of the drivers being also practically identical, we have the efficiency measured for the same piston speeds, and at closely equal rates of speed in miles per hour. In examining the plots for each engine, one, it should be noted, being a six-coupled and the other a four-coupled locomotive, there are at once certain features which attract attention.

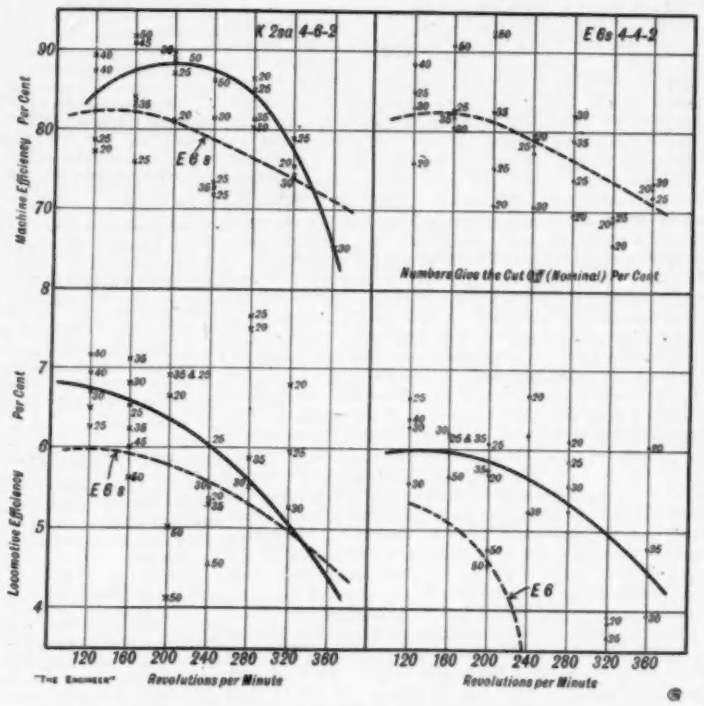


Fig. 1—Comparative Machine and Locomotive Efficiencies

The outstanding characteristics brought into prominence are (1) the high mean efficiencies indicated by the six coupled engine "K 2 s.a.," in comparison with the four-coupled engine "E 6 s," (2) the rapid fall in efficiency with increasing speed, and (3) the fact that at speeds below 240 revolutions per minute, the highest mechanical efficiencies are found at the longer rates of cut-off; both engines give more than 90 per cent. mechanical efficiency at 160 revolutions when the cut-off is at the rate of 50 per cent. On the other hand, at speeds above 240 revolutions, generally the shorter rates of cut-off seem to furnish higher mechanical efficiencies. There are, however, exceptions. For instance, in the case of "E 6 s" at 280 revolutions, 30 per cent. cut-off gives a better efficiency than 20, 25, and 35 per cent., whilst at 240 revolutions 20 per cent. gives a higher machine efficiency than 25, 30, or 38 per cent. cut-offs.

In order to develop, if possible, the cause for these results and to determine how the six-coupled engine comes to show a mean mechanical efficiency higher than the four-coupled engine, which is contrary to expectations, Table I. has been drawn up giving the test conditions as to speed and cut-off, the I.H.P., D.H.P., and the frictional or machine H.P., and from it Figs. 2, 3, and 4 have been prepared.

In examining more closely the results, as shown by Fig. 1, the thought is that the higher efficiency as exhibited by "K 2 s.a." may be due to its higher power, brought about by having 24in. as against 22in. cylinders, such power being greater in proportion to a possible and expected greater frictional horse-power, or it may be due to higher power alone, the frictional horse-power absorbed by the engine being equal to, or little different from, that absorbed by the four-coupled engine. Similarly, in examining more in detail the effect of cut-off on machine-friction, it is conceivable that the higher efficiencies at longer cut-offs at the lower speeds may be entirely due to the necessarily higher power output at any given speed at a longer cut-off, or it might be due in part to a reduction in the machine-friction caused by the more even bearing pressures brought about by less differences between the maximum and minimum forward pressures acting on the pistons, or, in other words, a mean indicated forward pressure more nearly equal to the initial pressure. In Fig. 1 mechanical efficiency is shown plotted against speed, and, as would be expected, there is a marked lowering in efficiency as the speed increases, but it is also clear from the diagram that at any speed alterations in the point of cut-off bring about a decided difference in the efficiency obtainable, and while the average lines drawn through the several points indicate the mean efficiency for each engine, it is, nevertheless, apparent that both plots show that the points cover what is in reality a zone area rather than a single line diagram.

In order to establish the comparative powers absorbed by machine-friction by each engine at any given cut-off and speed, Fig. 2 has been prepared. In it frictional horse-power has been plotted against cut-off, and, the various points being joined together for each of the speeds corresponding to the points thus obtained for each engine separately, information is readily given regarding the power in terms of frictional horse-power required by the two engines under similar operating conditions. The comparison arrived at is, it will be appreciated, independent of the fact that the six-coupled engine with 24in. cylinders, gives a proportionately higher cylinder horse-power than the four-coupled engine having 22in. cylinders. Whilst there appear to be exceptions, it seems clear that as a rule the six-coupled engine absorbs somewhat more power than the smaller four-coupled engine. This diagram also shows that at the lower speeds, those up to 240 revolutions, and the longest cut-off, the horse-power required by the frictional resistance of the engines is least.

Bearing in mind the general results given by Fig. 2, it may probably be safely assumed that the higher mechanical efficiencies shown by the six-coupled engine in Fig. 1 are in a considerable measure due to the fact that at each speed and cut-off the gross power developed, *i.e.*, the indicated power, is greater than the corresponding power furnished by the four-coupled engine, and, while in this case the six-coupled engine is the more efficient, the opinion cannot be formed that all six-coupled engines would show the same result. In fact, if the six-coupled and four-coupled engines had equal cylinder capacity, and other related characteristics were equal, then while there is little reason to suppose that the mechanical efficiency of the six-coupled engine would be less, it is equally certain it would not be greater, than that shown by the "Atlantic," as is indicated by Fig. 1. The cylinder power of the "Pacific" is for a given mean pressure 19 per cent. greater than that of the "Atlantic," so if it only absorbed an equal amount of power in machine-friction, it would still be expected to show a higher mechanical efficiency. The relationship between mechanical efficiency per cent. and frictional horse-power is shown by Fig. 3 A, in which has been plotted for each engine the efficiency against horse-power. It is evident from the relative positions of the average lines drawn through the plotted points that for any given frictional horse-power the machine efficiency of the "Pacific" type engine is greater than that of the "Atlantic," which goes to prove the conclusions arrived at as to why this engine should show a higher efficiency than the four-coupled engine, namely, that this result is obtained largely through the fact that it is, for any set of running conditions, the more powerful of the two, because it has larger cylinders. The plot, as in the case of the others, indicates that running conditions affect the results considerably, and the dotted curves seem to denote the limits imposed by these variations, and are drawn for the "Atlantic" "6 s."

The numbers against the plotted points indicate the speed and cut-off prevailing to give the results obtained. These, it may be pointed out, are similar for adjacent points for each engine. The elements of speed and cut-off being, therefore, alike, only the third variable, namely, power, remains to be considered, which goes to establish why the average line for "K 2 s.a." lies higher in the graph than that for "E 6 s." The reason is to be found in the higher power developed, since the frictional horse-power forms a smaller percentage of the total or I.H.P.

In order to obtain a comparison of the performance of these two engines on a power basis alone, Fig. 3 B has been made. Here frictional is shown plotted against indicated horse-power. Up to about 1600 I.H.P. there is little to choose between the two engines as to the power absorbed by machine friction for a given power at the cylinders. After that point the larger engine shows to advantage, the reason being that for a given power the "Atlantic," cylinder 22 by 26, has to run faster—r.p.m.—than the "Pacific," having cylinders 24 by 26. This is, of course, true for all powers, but the differences in the power absorbed in running the machinery are less at the lower rates than at the higher speeds. That this is so is easily seen in Fig. 1, where the sharp falling off in mechanical efficiency with increasing speed forms a distinctive feature of the plot.

From the above analysis, it would appear that the frictional resistances are, as would be expected, somewhat higher for a six-coupled than for a four-coupled locomotive. If, therefore, a six-coupled shows a higher mechanical efficiency than a four-coupled locomotive at any given speed in revolutions per minute, such increase in efficiency is due to a higher cylinder horse-power. This is, of course, no argument against the use of six-coupled locomotives for fast, or, indeed, any service, because actually if a six-coupled engine has larger cylinders, or perhaps better stated, a higher cylinder horse-power at any speed—r.p.m.—than a four-coupled locomotive, it will deliver a higher percentage of its cylinder horse-power at the tread of the driving wheels. On the other hand, if the cylinder power of the six-coupled locomotive is no greater than that of a four-coupled, owing to less axle loads, necessitating three-coupled axles to obtain an adhesive weight, which under different road conditions could be obtained by the use of two coupled axles, then the reverse would be the case, and the four-coupled engine would show the higher machine efficiency.

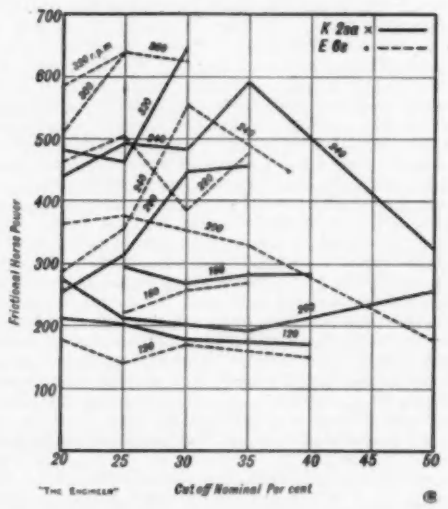


Fig. 2—Frictional H.P. Speed and Cut-Off

Fuel Consumption and Power.

In order to show how fuel consumption is related to power, Fig. 3 C has been prepared. The dry coal per dynamometer horse-power hour has been plotted against the power shown by the dynamometer. This information is shown for both the locomotives, and in order to avoid any confusion, the results are plotted in separate panels, which, besides giving the coal rates for the superheated steam locomotives "K 2 s.a." and "E 6 s.," give also for comparison the results on the same basis, dynamometer horse-powers, for "K 2" and "E 6" working with saturated steam. The striking feature brought out is the remarkably uniform consumption throughout a considerable range of power output, a characteristic before observed with superheated steam, and the more noticeable when the run of the curve given for "E 6" in the lower panel is noted.

The locomotive "K 2 s.a." shows that between the limits of 700 and 1850 D.H.P. a dry coal rate of less than 3 lb. is obtained, and between 1950 and 1600 D.H.P., but 2·5 lb. are required per D.H.P. hour. "K 2 s.a." gives generally a slightly lower coal rate then "E 6 s," a result to be expected in view of its better boiler evaporative performance seen when the efficiency of the two boilers was compared, and, further, the larger cylinders give a somewhat better steam rate per I.H.P. hour.

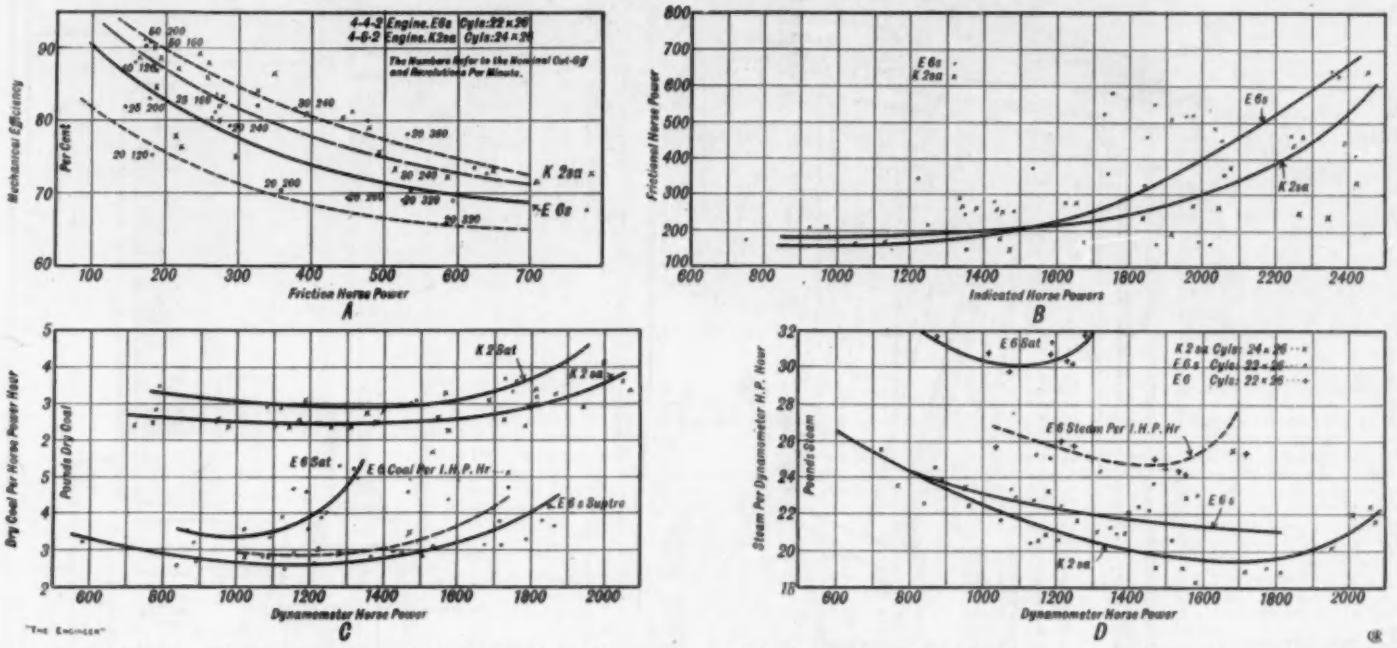
In the lower panel the dry coal per I.H.P. for "E 6" is shown for comparison with the fuel rate per D.H.P.

* "Locomotive Boiler Performance," The Engineer, February 22nd and 29th, 1924. "Locomotive Cylinder Performance," The Engineer, November 21st and 28th, 1924.

for "E 6 s.," and the interesting fact is established that "E 6 s." working with superheated steam actually gives a lower coal rate per D.H.P. than is obtainable per I.H.P. with "E 6" operating with saturated steam.

STEAM CONSUMPTION AND POWER.

The steam rate in pounds per dynamometer horse-power-hour is given by Fig. 3 D where the results obtained for each engine are shown, and also for comparison the consumptions obtained with "E 6." The "Pacific" type engine shows to advantage, and



A.—Frictional H.P. and Mechanical Efficiency. B.—Indicated and Frictional Horse-power. C.—Dry Coal per Dynamometer Horse-power. D.—Steam per Dynamometer Horse-power.

FIG. 3

what are believed to be very low steam rates are recorded, whilst the line indicating the mean results of the trials shows a steam rate of less than 20 lb. per D.H.P. hour between 1500 and 1750 D.H.P.

Another interesting comparison is obtained by plotting the steam rates per I.H.P. hour for the saturated steam engine "E 6." Here the steam rates for the superheated engines is seen to be very much lower than those given per I.H.P. hour for the saturated steam engine. The steam consumptions per D.H.P. hour when using superheated steam are much lower than the steam consumptions per I.H.P. usually

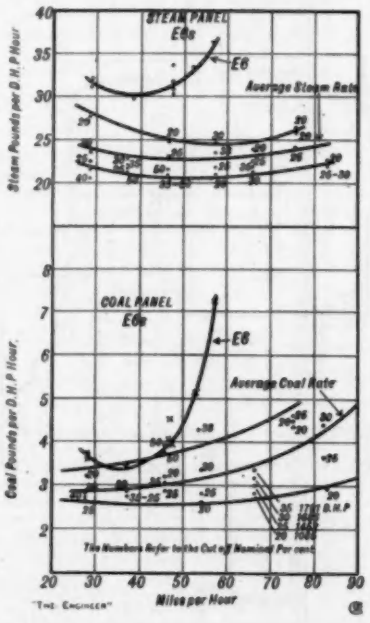


FIG. 4—COAL AND STEAM RATES AND M.P.H.

obtainable with saturated steam. These results and those indicating the coal rates in the previous figure again bring forward in a forceful manner the very considerable saving to be realised when superheated is supplied to the engines in place of saturated steam. Not only are the consumptions of steam and coal much reduced, but it is also evident that the range of power through which the locomotive may be run is greatly increased, and this at uniformly low consumptions of coal and water.

In connection with the foregoing remarks, it may be as well to point out that the results are obtained by making no alterations to the locomotives, except the fitting of the superheating equipment, which actually entails a reduction of some 25 per cent. in the evaporative heating surface.

COAL, STEAM, AND SPEED.

The fuel and steam rates per dynamometer horse-power and their relation to speed in miles per hour are given by Fig. 4, the upper panel showing how the steam consumption per D.H.P. hour is effected at all speeds between 23 and 84 miles per hour, whilst in the lower panel similar information is given for the coal consumption, dry coal, per D.H.P. hour. The figure gives this information for the "Atlantic" locomotive "E 6 s.," and also for "E 6." Here, again, is indicated by the rather scattered points in each plot that the results cover what may be termed a zone area rather than a single curve, though average lines have been drawn through points indicating the mean results for the several tests.

The steam panel shows that, within the range of speeds covered by the tests, the water rates may run from about 22 lb. to just above 20 lb. per D.H.P., and the average results indicate consumptions of from 24·5 at low speeds to about 22 at 60 miles per hour, and that "E 6" would require at the same speed about 35 lb. or 36 lb., a saving on a speed basis of 38 per cent. in favour of the superheater locomotive.

The manner in which cut-off influences steam consumption per unit of power developed at any of the several speeds is well shown, and thus in an interesting way is seen the increase in the water and, from the lower panel, the coal required when operating increasingly heavy trains at high average speeds requiring, of course, correspondingly greater power output from the locomotive.

The coal rate records in the lower panel can be seen for any given water rate and an average line drawn through the zone covered by the points plotted indicates mean fuel rates varying from about 2·75 lb. to 4·75 lb. per D.H.P. as the speed and power increases. Attention is drawn to the four tests run at just over 65 miles per hour—280 r.p.m., 65·6 m.p.h.—and at nominal rates of admission of 20, 25, 30, and 35 per cent. Against each of these points in the coal panel has been added the corresponding D.H.P., and it will be noted that at this speed, which may be considered usual for an express engine of this particular type, from 1085 to 1791 D.H.P. may be developed at coal rates of from 2·8 lb. to 3·3 lb., and from the steam panel, at water rates of from 20·5 lb. to 23 lb. per D.H.P. hour.

The comparative uniformity of the coal and water rates between, say, 30 and 70 miles per hour, are very noticeable, and in great contrast with the mean consumptions obtained with locomotive "E 6," which evidently develops heavy coal and water consumptions at about 55 miles per hour, at which speed this locomotive was working at a power output of 1161 D.H.P., and at a nominal cut-off of 30 per cent. At 52·5 miles per hour, this engine developed 1702 I.H.P. and 1319 D.H.P. on coal and water rates of 5·2 lb. and 32 lb. per D.H.P. hour. The nominal cut-off was 30 per cent., and the average boiler pressure maintained was 198·7 lb. per square inch throughout a 45-minute test.

(To be continued.)

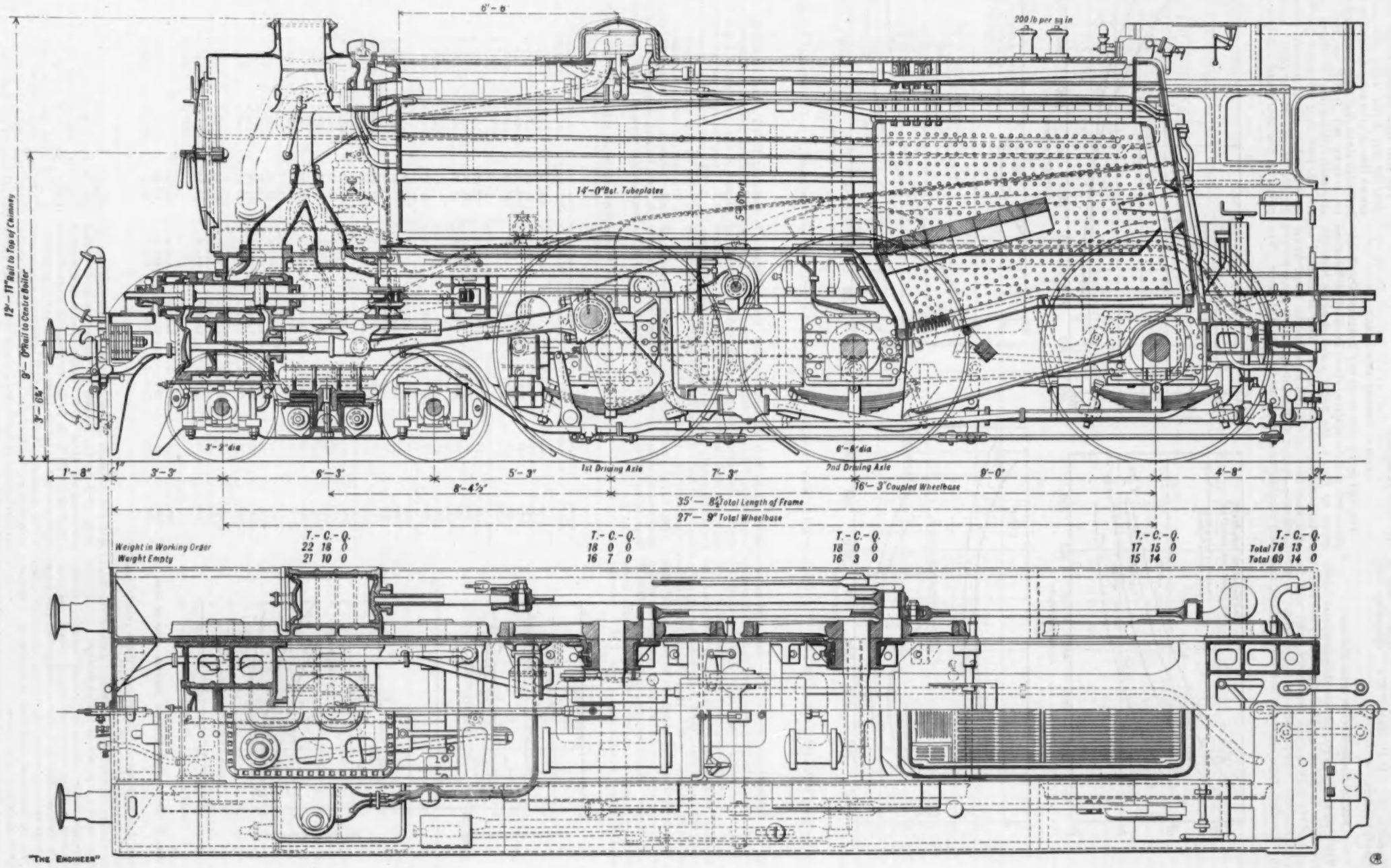
TABLE I.—*Comparative Power and Frictional Horse-power at Equal Speeds and Cut-offs.*

Speed, r.p.m.	Cut-off, per cent.	"E.6 s." I.H.P.	"E.6 s." D.H.P.	"E.6 s." M.H.P.	"E.6 s." Efficiency.	"K 2 s.s." I.H.P.	"K 2 s.s." D.H.P.	"K 2 s.s." M.H.P.	"K 2 s.s." Efficiency.
120	20	756·1	576·1	180·0	76·19	931·5	719·8	211·7	77·27
120	25	973·7	830·4	143·3	85·28	972·5	763·8	208·1	78·56
120	30	1055·1	878·2	176·9	83·23	1129·6	952·0	177·6	84·28
120	40	1356·7	1202·4	154·3	88·63	1448·3	1260·5	187·8	87·03
120	40	—	—	—	—	1463·6	1305·1	158·5	89·17
160	25	1265·1	1091·0	224·1	82·29	1239·8	942·5	297·3	76·02
160	30	1356·1	1093·3	263·1	80·60	1441·3	1171·3	270·0	83·27
160	35	1489·2	1219·4	269·8	81·88	1624·4	1347·3	281·0	83·11
160	35	—	—	—	—	1663·8	1382·8	277·1	82·94
160	45	—	—	—	—	1984·5	1799·4	185·1	90·67
160	50	1880·0	1708·4	171·6	90·87	2047·8	1866·4	181·4	91·14
200	20	1228·8	871·0	357·8	70·88	1430·6	1155·0	275·6	80·74
200	25	1529·3	1153·7	375	75·44	1687·4	1475·9	211·5	87·47
200	35	1844·7	1519·8	324·9	82·39	1908·7	1717·5	191·2	89·98
200	50	1994·3	1817·3	177·0	91·12	2270·0	2008·7	261·3	88·49
200	50	2016·0	1843·3	172·7	91·43	2339·7	2089·5	250·2	89·31
240	20	1424·0	1136·0	288·0	79·78	1634·4	1187·7	446·7	72·67
240	25	1735·4	1368·4	366·9	78·86	1910·0	1399·2	510·8	73·26
240	30	1875·5	1322·5	553·0	70·51	2073·1	1681·0	389·1	81·23
240	35	—	—	—	—	2160·5	1566·4	594·1	72·50
240	38	2043·7	1592·9	450	77·94	—	—	—	—
240	50	—	—	—	—	2411	2080·9	330·1	86·31
280	20	1554·1	1085·7	468·4	69·86	1829·8	1575·2	253·6	86·14
280	25	1965·2	1452·0	515·2	73·81	2104·0	1781·7	322·3	84·68
280	30	2065·4	1686·8	376·8	81·76	2258·6	1811·4	477·2	80·20
280	35	2265·4	1791·3	474·1	79·07	2399·9	1943·9	456·0	81·00
320	20	1721·4	1195·4	526·0	69·44	2033·1	1542·7	490	75·88
320	20	1741·5	1153·2	588·3	66·22	—	—	—	—
320	25	2116·8	1471·9	644·9	69·53	2290·3	1815·0	475	79·25
320	30	—	—	—	—	2457·3	1810·9	646·4	73·69
360	20	1993·6	1416·8	516·8	73·27	—	—	—	—
360	25	2350·1	1705·0	645·1	72·55	—	—	—	—
360	30	2355·2	1730·0	625·2	73·45	2573·2	1682·6	890·6	65·39

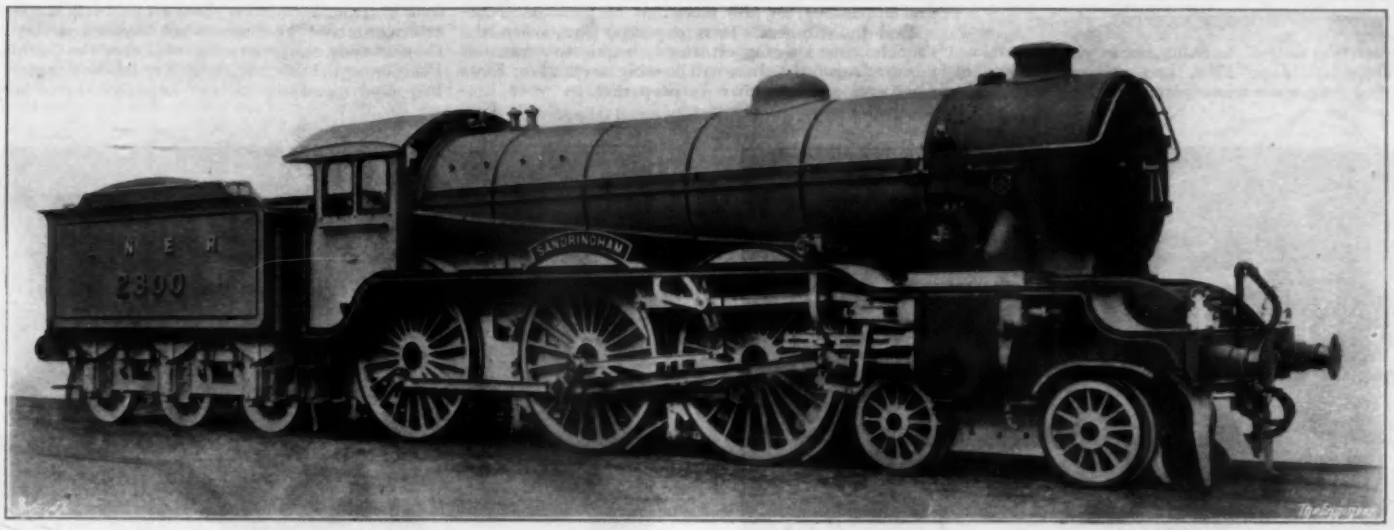
L. AND N.E. RAILWAY—THREE-CYLINDER PASSENGER LOCOMOTIVE FOR THE G.E. SECTION

MR. H. N. GRESLEY, M. INST. C.E., M.I. MECH. E., ENGINEER

(*For description see opposite page*)



L. AND N.E. RAILWAY—THREE-CYLINDER EXPRESS PASSENGER ENGINE



Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

"OLD CONTEMPTIBLES."

SIR,—The letter over the signature of "John of Aylestone" will find an echo in many a middle-aged heart in these piping times of war's aftermath, somewhat similarly aged, and somewhat similarly situated. I am thinking of the new countries myself. England has become a pleasant garden in which to retire, or such parts of it as are not yet ruined by modern transport; but to-day it is no country in which sound schemes find much support. By sound schemes, I mean the enterprise associated with development: ships, bridges, water, railways, and the heavies generally; but I think a man of fifty may still make good in the outlying parts of Empire, where his experience in these branches is wanted. Canada is not so far away, and provided the aspirant can wean himself from many comforts to which he is accustomed and indeed entitled, if he will but face the fact that the war has altered all values, I believe it is his best chance. Anyhow, I hope soon to make the experiment.

A FELLOW SUFFERER.

S. Devon, July 3rd.

SIR,—"John of Aylestone" should know that he is by no means alone in his hard plight, nor can he even take consolation from the fact that it is because he has no College training. There are hundreds, nay, thousands of others, who are in like case. I know, because I am one of them, but I am leaving a country—that is so particular about a man's age—to seek fresh fields and pastures new.

"John of Aylestone" should bear in mind the question put to the widow lady when she was up against it: "What hast thou in the house?"

If he will carefully take stock of what he has gained from his past experience and apply it to his present needs, and not rely upon advertisements but develop his own leads in a real selling campaign of his own services, he will get a job. It may not be a very nice job, but it can always be made into something better.

July 3rd. JOHN OF GAUNT.

SIXTY YEARS AGO.

WE are no doubt justified on the whole in our frequent criticism of the manner in which earlier generations plentifully bestrewed our chief cities with statues, not always artistic, of the celebrities of their day. London in particular suffers from a superfluity of indifferent memorials in bronze or stone to personages of forgotten fame. But while we criticise the deeds or misdeeds of our predecessors in this respect, we must be careful not to lay the blame on any particular generation or period. In especial we must not single out the mid-Victorians for censure. They, no doubt, added a fair quota of statues to the streets of London, but, perhaps more from a certain narrowness of vision than from a commendable restraint, they on occasion held their hands when they might have been busy. Some of the influences at work sixty years ago governing the erection of public statues were unworthy of our national life, and were seen to be such by many of the people. Some time in the 'sixties a seated statue of Jenner, the discoverer of vaccination, was erected in Trafalgar-square. The sons of Mars raised an outcry against it. It was intolerable, they said, that a monument to a "mere quacksalver" should be reared amidst memorials to a Nelson, a Napier, and a Havelock. With, it was believed at the time, the connivance of the Government, Jenner's statue was stealthily removed one night and stowed away in an obscure corner of London. Then Faraday died, and the Presidents of all our great learned societies in a body advanced the proposal that a monument to him should be erected at the public expense. The Government, however, declined to move in the matter. It could not "consent to the appropriation of public money for the erection of a monument *to any private citizen, however illustrious.*" In our issue of July 2nd, 1869, we expressed our indignation with this attitude of the Government. We consoled ourselves and our readers with the thought that Faraday's fame would not be dependent on the erection of a statue, and that the revelation of physical truth was a surer title to immortal memory among men than anything else a human being could effect. When the canvas was rotten and holed, when the statue was a limbless, headless trunk, when the column was prostrate, when the music was forgotten, when even the book and the record had perished, the fame of the private citizen who had identified the five electricities, explained the liquefaction of gases, discovered the laws of universal magnetism, and proved the relationship which existed between magnetism and light would still be remembered. Convinced though we were on this point, we, probably as a concession to the current taste, approved of the proposal to erect a statue to Faraday by private subscription. We suggested that Trafalgar-square should be left free to the conquerors and first gentlemen of Europe, and that Faraday's statue should be erected in the forecourt of Burlington House, then being erected for the Royal and other societies. In time that space might become the Walhalla for our real kings of men.

BOOKS OF REFERENCE.

"KELLY'S Directory of the Merchants, Manufacturers and Shippers of the World," published by Kelly's Directories, Ltd., 186, Strand, London, W.C. 2. Two volumes, price 64s. post free.—It is quite needless for us to describe fully the contents of these two books; they are too well known and valued. It will suffice to say that the present issue—the forty-third edition—in addition to comprising more than one and a-half million names, and dealing with over 20,000 places, is a veritable gazetteer and contains a mass of valuable facts and figures. The books cover the whole world and are indexed in four languages—English, French, German, and Spanish. Volume I. deals with foreign countries and their possessions, while Volume II. is concerned with Great Britain, India, and the British Dominions, Colonies, Protectorates and Dependencies. That part of Volume II. which is devoted to Great Britain has been subdivided into the following sections:—(1) England, Scotland and Wales; (2) London; and (3) Ireland. Each of these sections is again split up into the following sub-sections:—(*a*) Alphabetical; (*b*) classified trades; (*c*) telegraphic addresses; (*d*) exporters; and (*e*) importers. We are continually referring to both volumes and find them invaluable.

"UNIVERSAL Directory of Railway Officials, 1929," published by the Directory Publishing Company, Ltd., 33, Tothill-street, Westminster, S.W. 1, price 20s. net.—The thirty-fifth annual edition of this unique book of reference has just reached us. We use the word "unique" advisedly; there is no other single volume, that we know of, at any rate, which contains lists of all the chief railway officials all over the world—Great Britain, Europe, Africa, America, India, Australasia, North and South America, the Far East, &c. These lists, too, may be regarded as being official, since proofs of them have been submitted to, and corrected by, railway administrations in all parts of the world. As regards the railways of this country we can bear testimony to the fact that, so far as we have been able to check it, the information given is thoroughly up to date. There is no need, at this late date, to go in detail into the contents of the volume, and we need only say that it is divided into the following ten sections:—Official; Great Britain; Ireland; Europe; Asia; Africa; Australasia; North America; Central America; Mexico and the West Indies; South America; Personal Index of Railway Officials, &c.

"THE Railway Year Book for 1929," which is published at the offices of the *Railway Magazine*, 33, Tothill-street, Westminster, S.W. 1, price 5s. net, is the thirty-second annual edition of this useful book of reference. In the present issue some additions and changes have been made. In the first place, in response to requests that the book should include information regarding European, United States, and other railways, new sections have been added. The European section is classified according to States, and under each heading particulars are given of the principal railways, with some notes as to gauge, numbers of locomotives, coaching vehicles, freight stock and headquarters. In the case of the United States railways there is a list of all the principal railways, which is prefaced with some general statistics indicating the scale of operation and the main of the United States railways as a whole. Alterations have also been made with regard to the form in which the data concerning non-British railways in other countries, especially Asiatic—other than Indian—African and Central and South American, are presented. In the home railways and general sections, too, extensive revisions have been made, and a new map of the Southern Railway has been included.

"THE Advertiser's A.B.C., 1929." Compiled and published by T. B. Brown, Ltd., 163, Queen Victoria-street, E.C. 4. Price 21s. net.—This is a useful reference book for anyone engaged in the advertising side of newspaper work, whether advertiser, publisher, or agent. The information contained has been carefully compiled and classified under various headings, making the book a handy and quick guide to much that is an every-day necessity to publicity men.

"TRAUTWINE: The Civil Engineer's Reference Book." Twentieth edition, 150th thousand, third issue, 1929. London: Chapman and Hall, Ltd., price 35s.—The first issue of the twentieth edition of this extraordinarily useful book of reference was made in 1919 and the second in 1922, and now comes the third, which constitutes the 150th thousand. In all respects it appears to be similar to its forerunners, saving that the description "Pocket Book" has been changed to "Reference Book," and that an article on "Dredges"—or, as we call them here, dredgers—"and Dredging," has been added. We learn, too, from the preface, which only extends, by the way, to five lines, that "all known errors have been corrected," and that the price list, bibliography and index have been revised. There is little wonder that this book, which is the outcome of the labours of three generations of Trautwine, is so highly valued by engineers on the other side of the Atlantic, for it is encyclopædic in its contents, and fully merits the epithet of monumental.

L. AND N.E. RLY.—PASSENGER LOCOMOTIVE.

IN the annual review of locomotive progress, which appeared in our issue of January 4th last, we gave some particulars of the 4–6–0 three-cylinder engines specially designed by Mr. Gresley for the Great Eastern Section of the London and North-Eastern Railway, on which some of the bridges are not strong enough to take the "Pacifics" which work the Northern routes. To-day, through the courtesy of Mr. Gresley, we are able to give on the opposite page a drawing of one of these engines, a photograph of which—the "Sandringham"—appears above. A feature in the design which should be particularly noticed, is that the middle cylinder drives on to the first coupled axle instead of on to the second, as in Mr. Gresley's other three-cylinder designs. Owing to the excellent balance and reduction of hammer-blow that results from the use of three cylinders a load of 18 tons per driving axle was accepted by the civil engineers in place of the 15 ton 13 cwt., which is the limit for the old G.E.R. two-cylinder designs.

A full table of dimensions and ratios was given in our issue of January 4th, but for the convenience of readers who want only the main particulars, we may say that the cylinders are 17½ by 26, the pressure 200 lb. at the boiler, and the drivers 6ft. 8in. diameter. The grate area is 27½ square feet, and the evaporative surface 1676 square feet. The cylinder horse-power is 1653, and the tractive effort at 85 per cent. of the boiler pressure 24,379 lb. An order for ten engines of this class was placed with the North British Locomotive Company, Ltd., last year.

AN exhibition of chemical apparatus and machinery is to be held in Frankfurt-on-Main from June 10th–22nd, 1930.

Institution of Electrical Engineers.

No. III. (*conclusion*).*

SUMMER MEETING.

THOSE who visited the Saint Assise wireless stations on Thursday, June 13th, had an opportunity of studying long-wave transmitters working with high-frequency alternators and short-wave transmitters with valves. The equipment for the public telephone service established at the beginning of this year between Paris and Buenos Aires created great interest. Owing in a large measure to the type of directional aerial employed, the service is said to be highly officient. The aerial and reflector—see Figs. 10 and 12—consists of a network of wires, each unit of the net forming in effect a half-wave aerial. All the wires that are inclined to the right are of the same phase; those to the left are in phase opposition—see Fig. 17. Power is supplied at two centre points. The upper and lower parts, known as the shadow zones, are not supplied with power, but, owing to electro-static and electro-magnetic induction, they nevertheless carry current, the action of which is added to that of the other part of the aerial. The upper portion is connected to the triatic and the lower part to earth, and the effect of the general design is to produce maximum radiation in a direction parallel with the ground.

Behind the aerial at a distance of about one-fourth of the wave length from it is the reflector, which is constructed on exactly the same lines as the aerial. Under normal conditions the reflector leads are not, of course, connected to the transmitter, but are simply short circuited. Obviously, by suitable switching arrangements the aerial can be made to act as a reflector and the normal reflector as the aerial, thus shifting the radiation through 180 deg. It is an easy matter to tune the screen (energised with current leading $\frac{\pi}{2}$ degrees in advance of the aerial current) to the exact wave length and to modify this tuning if the wave length changes; moreover, by slightly altering the adjustment it is possible to give the beam a slight vertical inclination.

On the Saint Assise wireless transmitting centre much more might be written, but the remainder of the story must be told by Figs. 8, 9 and 11, which show the high-frequency alternators for the long-wave transoceanic wireless telegraph service, the power plant for that service, and part of the valve short-wave transmitting equipment for the Paris–Buenos Aires wireless telephone service.

A visit was paid on the afternoon of June 13th to the works of the Establissment Belin, where the party saw apparatus for the reception of pictures transmitted by wireless. It is expected that, when the French broadcasting stations begin to transmit pictures regularly, there will be a big demand for these receivers, and the firm is preparing to meet that demand. Several types of receiving apparatus suitable for the reproduction of different kinds of pictures were on view. One of the receivers, which gives excellent results, depends for its action upon variations of current passing through chemically treated paper. The treated paper on which the picture is reproduced is wrapped round a drum maintained in synchronism with the transmitter, and variations of the current passing from a stylus through the moist paper to the drum produce the picture.

The 46,000 Gauss electro-magnet at the Station Nationale de Researches et Experiences Technique at Bellevue was inspected on Saturday, June 15th, the last day of the Paris section of the meeting. The coils of this magnet, which is being used for research work, are 10ft. in diameter and 6ft. long. The distance which separates them can be varied. Some who took their cameras with them on this trip discovered afterwards that the shutters had been magnetised. On the same day the generating station of the Compagnie Parisienne de Distribution at Issy-les-Moulineaux was inspected, a station which we hope to describe fully at some future date. The original steam pressure has been increased and the high-pressure machines discharge into the original steam mains which supply steam to the original turbines. The major part of the time spent at this station was taken up by a cinema entertainment, showing the construction of the high-pressure steam drums.

From a technical point of view the most important visits during the Pyrenees tour were those to the electrical installations of the Midi Railway. So much has been written on the electrification of this railway that it is scarcely necessary to consider anything beyond that which we actually saw. Everyone knows that its current is derived from water power stations; that the lines are worked with 1500-volt direct current; and that 60,000-volt three-phase overhead feeders follow the railway. Besides these 60,000-volt lines there are 150,000-volt lines for long-distance transmission. These lines have a larger capacity than is needed by the railway and also serve for the general distribution of current from many hydro-electric stations working in parallel. In all, the company has sixteen generating stations in operation or under construction; other hydro-electric stations belonging to other companies feed into the same transmission system. The water power station, Le Hourat—Fig. 13—which contains five 8000 kVA sets running at 500 revolutions per minute, generating current at 10,000 volts, was visited on June 18th. The outdoor switching equipment and overhead high voltage line equipment associated with this station is shown in Fig. 14.

Many outdoor structures of a similar nature and forming switching and transforming stations are now to be seen in France. They can scarcely be said to harmonise with the surroundings, but they have the advantages of being relatively cheap and effective. Lightning arresters of the lead oxide film type appear to be universally employed in connection with these outdoor stations. As most electrical engineers know, the action of these arresters depends upon the change in resistance which takes place when certain inorganic

FIG. 8—HIGH-FREQUENCY ALTERNATORS

FIG. 9—DIESEL ENGINE POWER PLANT

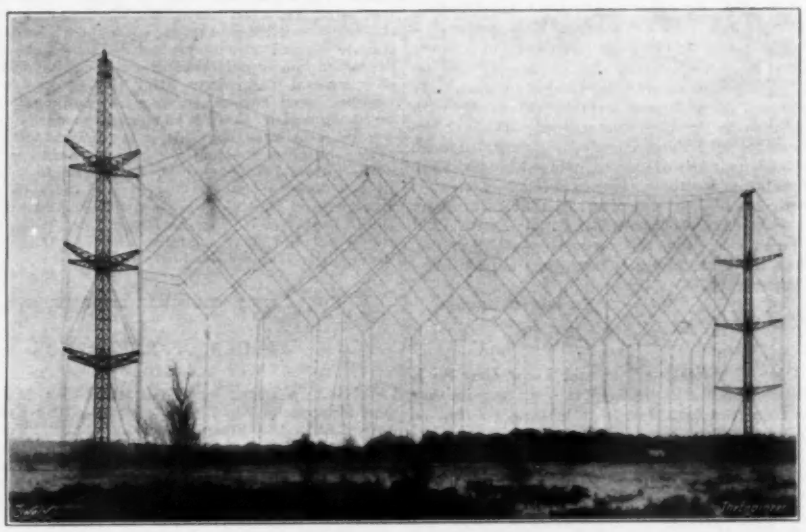


FIG. 10—SAINT ASSISE SHORT-WAVE DIRECTIONAL AERIAL

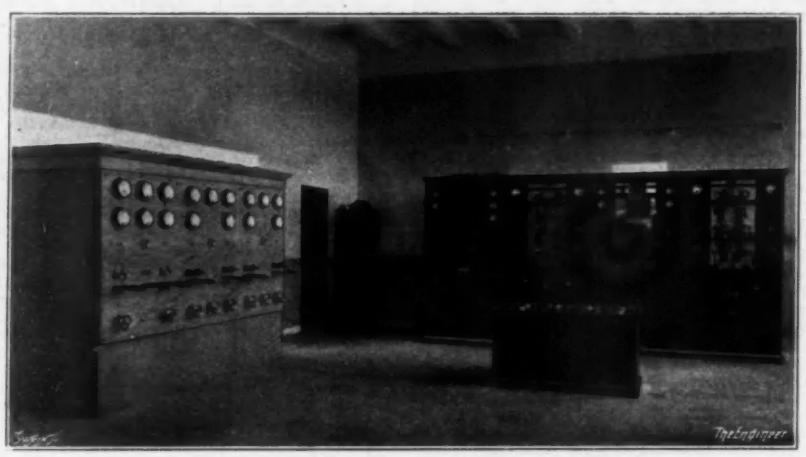


FIG. 11—PART OF SHORT-WAVE TRANSMITTING ROOM

* No. II. appeared June 28th.

salts are heated. The salt used is lead peroxide, which, when heated, gradually loses oxygen until finally at 250 deg. Cent. it is converted into litharge, which is practically an insulator. The cells of which these arresters are composed consist of two Sherardised iron plates separated by a porcelain ring, and the space between the two plates is filled with lead peroxide. The surface of the electrodes is covered with a film of varnish, which will break down at a pressure of about 400 volts. On the occurrence of a discharge a breakdown occurs through the film of varnish at one or more points, and the current which flows heats up the peroxide in the neighbourhood of the puncture, thereby converting it into an insulator. The puncture is thereby immediately sealed and the flow of current is stopped. The arrester therefore acts like a valve. In time the whole surface of the electrodes would naturally be covered with small films of litharge, but it is said that these litharge films act in the same manner as the original varnish films, so that the life of the arrester is indefinitely long. It will, of course, be understood that a complete arrester is composed of a number of cells and that it is connected to the line through a spark gap.

Sub-stations for connecting the three-phase alternating into direct current for the operation of the trains on the Midi Railway have been erected at distances varying from 8 to 20 miles, the drop in the line voltage under normal service conditions not exceeding 20 per cent. Different types of converters are in use. Some of the sub-stations contain two 750-volt rotaries connected in series. Others contain 1500-volt rotaries, and there are also mercury vapour rectifier sub-stations. The 1500-volt machines in use on the Midi Railway are believed to be the first 50-cycle rotaries designed for this high pressure. There have been many discussions on the relative merits of two series-connected 750-volt machines and 1500-volt converters, but we were unable to discover which of the two schemes is favoured by the Midi Railway engineers. Apparently, no definite conclusion has been reached. In the Hourat generating station there are two semi-automatically controlled 1500-volt converters which apparently work quite satisfactorily; at any rate, there were no signs of bad sparking or flashing between the brushes. The machines were supplied by Cie. Electro-Mécanique. Automatic control, we were told, was adopted at this generating station to test the merits of the automatic gear. We shall not attempt to describe the equipment, but attention may be drawn to the method of starting, which will be understood from Fig. 18, in which, for the sake of simplicity, only one phase is shown. From the transformer secondary A current first passes by way of the switch or contactor B into the stator winding C of the starting motor, which has the same number of poles as the converter D. After the machine has attained speed, current is allowed to flow into the converter armature through the choke F, the circuit being closed at E the contactor or switch B being opened. Thus, the machine is pulled into synchronism by current passing through the choke F. Finally, the switch B makes connection with the right-hand contact, and the choking coil circuit is broken at E. Schemes, somewhat similar in nature, we believe, have been adopted by English manufacturers.

The Haut-de-Gan sub-station, shown in Figs. 15 and 16, is an example of one of the sub-stations containing sets composed of two 750-volt rotaries connected in series. The most interesting feature of these machines is perhaps the device employed to ensure good commutation under adverse working conditions, such as short circuits. In series with one of the direct-current leads a transformer D.C. is connected as shown in Fig. 19. The secondary winding C is joined across the commutating pole windings, and as long as the current remains steady it has no effect. Sudden rushes of current in the direct-current circuit,

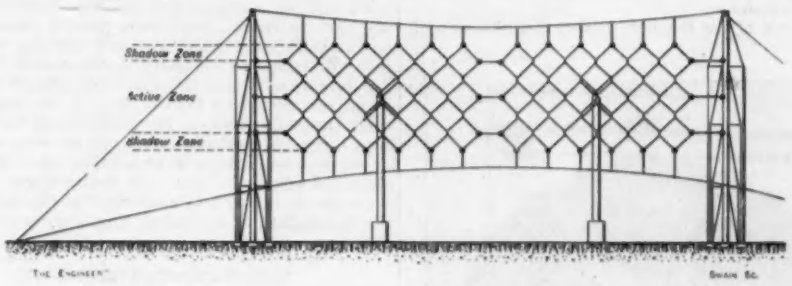


FIG. 12—ARRANGEMENT OF SHORT-WAVE DIRECTIONAL AERIAL

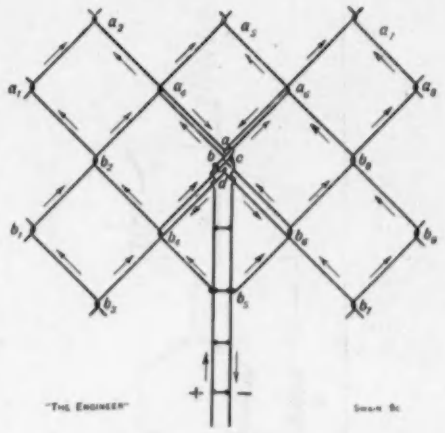


FIG. 17—METHOD OF FEEDING AERIAL

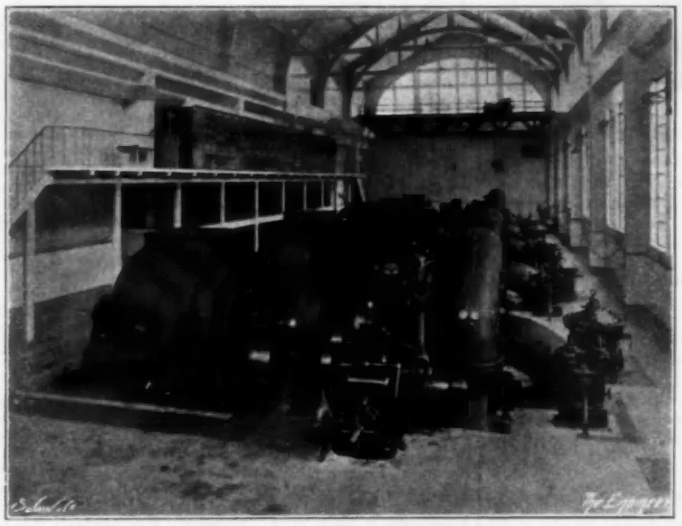


FIG. 13—LE HOURAT GENERATING STATION

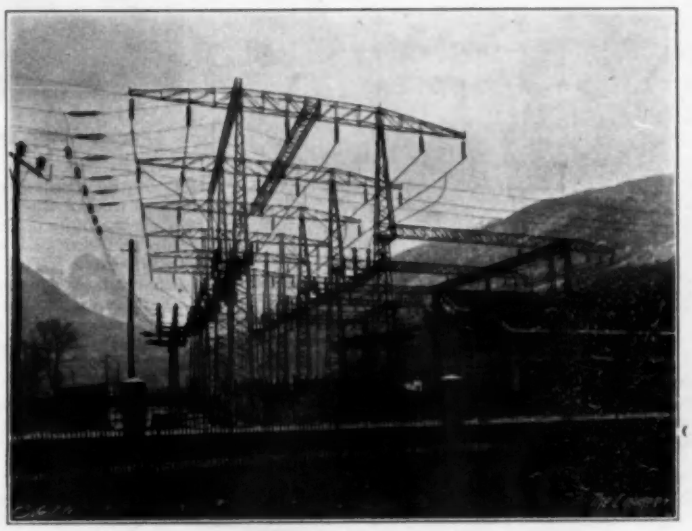


FIG. 14—OUTDOOR EQUIPMENT AT LE HOURAT

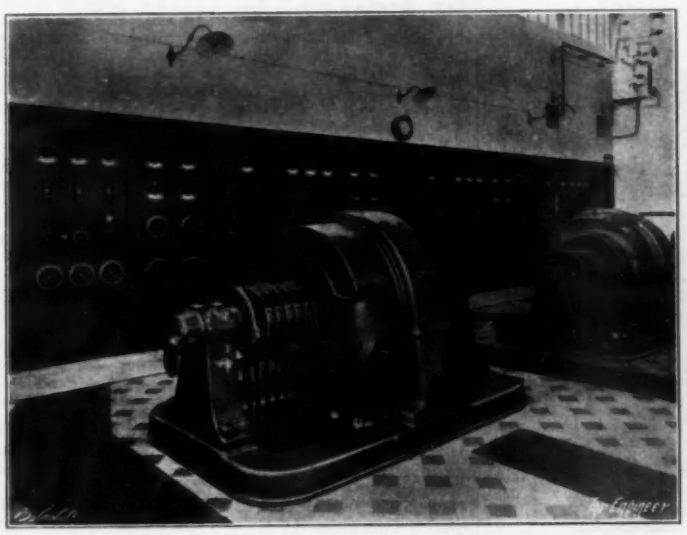


FIG. 15—HAUT DE GAN ROTARY CONVERTER SUB-STATION

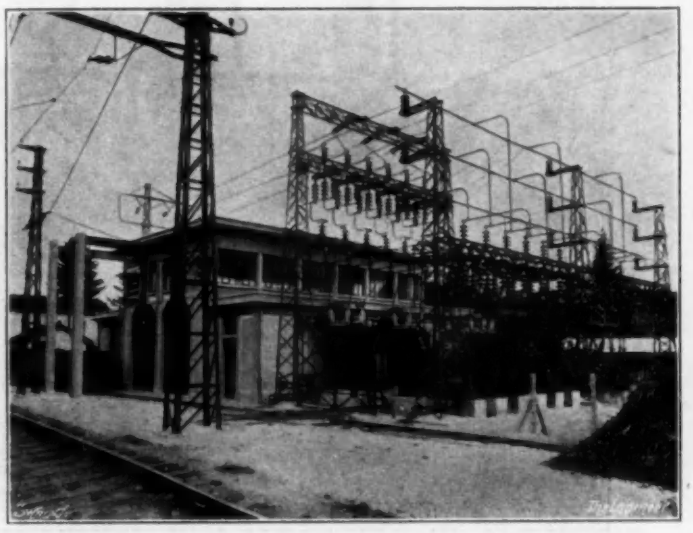


FIG. 16—EXTERIOR VIEW OF SUB-STATION—HAUT DE GAN

however, have the effect of inducing an E.M.F. in C, and of strengthening the field of the commutating winding B. In the case of a rapid fall in the current, the action is reversed. The primary winding D also gives

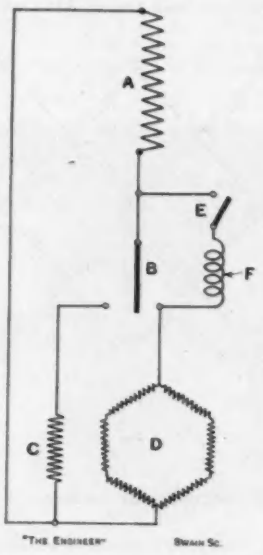


FIG. 18—CONVERTER CONNECTIONS

a choking effect which tends to check rapid fluctuations of current.

The Pau sub-station, which was visited on Monday, June 17th, is one of the Midi Railway rectifier sub-

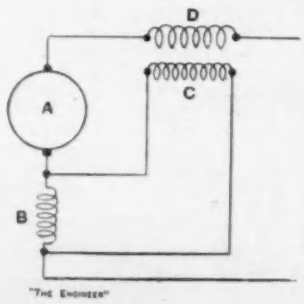


FIG 19—COMMUTATING POLE CONNECTIONS

stations; others are situated at Lourdes, Tarbes, Montréjeau, and Lannemezan. The electrical equipment of the first four sub-stations is identical, and consists of six 600-kW, 1500-volt mercury vapour

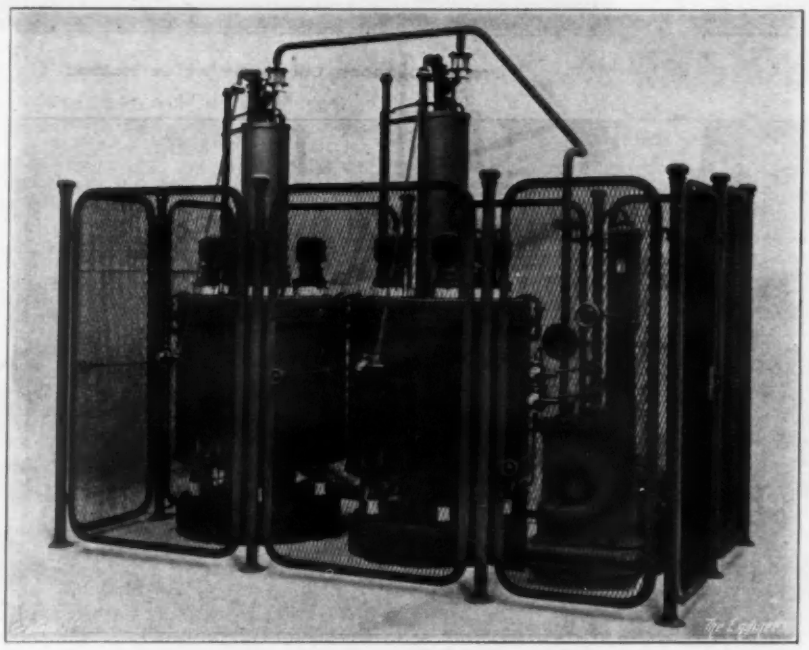


FIG. 20—MERCURY VAPOUR RECTIFIERS

rectifiers, together with high-tension A.C. switchgear, 1500-volt D.C. switchgear, and the usual equipment, such as vacuum pumps, &c., associated with the Brown-Boveri rectifiers. The rectifiers are mounted in pairs, as shown in Fig. 20, forming 1200-kilowatt units. Including the plant at the Lannemezan, the total output of rectifiers on the Midi Railway is 19,200 kilowatts. That these rectifiers are giving satisfaction there seems to be no doubt; at any rate, the Midi Company is equipping four other sub-stations with similar devices. Two will each contain two 1500-kilowatt, 1500-volt sets, and the remaining two four 600-kilowatt sets. Thus the company is adding 10,800 kilowatts to its present rectifier equipment. Incidentally, we learnt during the meeting that metal-cased rectifiers are being constructed in this country, and that an important London traction sub-station is to be equipped with them. Those who have watched rectifier progress abroad can scarcely fail to have realised that sooner or later they would be made in England.

The lay-out of the Pau sub-station is identical with

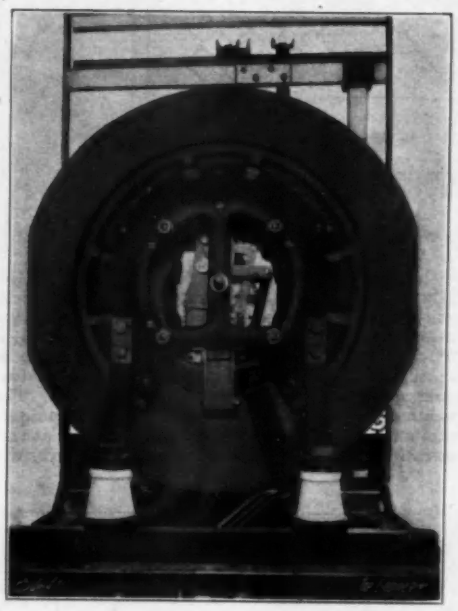


FIG 21—HIGH-SPEED CIRCUIT BREAKER

that of the Montréjeau sub-station; it is also the same as that of the Lourdes station, with the exception of the lines. The Lannemezan sub-station is larger and contains eight rectifiers, each rated at 600 kilowatts. The noiseless operation of these rectifier sub-stations makes it difficult to realise that their function is the same as that of rotary converter sub-stations, namely, to turn alternating current into direct current. Operators are said to prefer rectifiers to rotary converters, because of the absence of noise. Short circuits merely have the effect of opening the high-speed circuit breakers—see Fig. 21—whereas with rotary converters bad short circuits are apt to give rise to severe flashing at the brushes. Rectifiers can, moreover, be put into service with very little trouble, for they do not need synchronising. The efficiency of the rectifiers is high, and varies very little with the load.

During the various trips in the Pyrenees a great deal of cheap distribution work was seen, but it is doubtful if British electrical engineers will ever be permitted to erect such flimsy lines as some which came to our notice. Every place that was visited had an electricity supply, which, of course, was only to be expected. While the 150,000-volt transmission lines supply large centres, such as Bordeaux and Toulouse, the 60,000-volt lines which follow the railway everywhere feed step-down transformers in sub-stations from which distributing lines emerge. Railway electrification and general industrial electrification in France are combined, and in due course electricity will meet all requirements.

Of all the Institution's summer excursions that we have attended, none have proved more instructive and enjoyable than this year's meeting. The hospitality extended to the party by the Société Française des Electriciens and the personal interest which its President, Monsieur Bunet, and its Secretary, Monsieur Grosselin, took in the proceedings will, we feel sure, long be remembered by those who took part in the trip, and it is to be hoped that when the French electrical engineers next visit this country they will be made as happy and contented as the members of the Institution of Electrical Engineers were made in France.

Proposed International Road Congress, Washington.

As already announced, the Congress of the United States has issued an invitation to the Permanent International Association of Road Congresses to hold the next Congress in Washington in October, 1930. The British Government is a member of the Association and hopes to be represented at the Congress. Numbers of Highway Authorities and Associations concerned with roads and road transport likewise expect to be represented at this international gathering, when important problems of road construction and finance, as well as traffic, will be discussed. Previous Congresses have been held in Paris, Brussels, London, Seville, and Milan.

The following have been invited by the Association to collaborate in the preparation of the British reports to be presented at the Congress:—

First Question.—Results obtained by the use of (*a*) Cement (methods employed for road construction and maintenance in these materials):—Messrs. D. A. Donald, Chief Engineer of the Glasgow–Edinburgh Road, Glasgow; J. B. L. Meek, M. Inst. C.E., Chief Engineer, Manchester; and S. H. Morgan, M.C., M. Inst. C.E., Borough Surveyor, Rochdale; and Major R. A. B. Smith, M.C., A.M. Inst. C.E., the British Portland Cement Association. (*b*) Bricks or Other Artificial Paving (methods employed for road construction and maintenance in these materials):—Messrs. E. A. Evans, A.M. Inst. C.E., F.S.I., County Engineer, Denbighshire County Council, Ruthin; James Lang, Surveyor to the Kilmarnock District Committee, Ayr; Robert S. Murt, A.M. Inst. C.E., County Surveyor, Staffordshire County Council; S. McPherson, General Secretary, the Institute of Quarrying; and Ambrose W. Cross, the Midland Brick Association; and Colonel T. H. Chapman, the Rubber Growers' Association.

Second Question.—The most recent methods adopted for the use of tar, bitumen, and asphalt in road construction.—Professor R. G. H. Clements, M.C., M. Inst. C.E., Consulting Engineer; and Messrs. E. J. Elford, M. Inst. C.E., Borough Engineer, Wandsworth; H. R. Hepworth, A.M. Inst. C.E., County Surveyor, West Riding of Yorkshire County Council; F. Kilpatrick, the British Road Tar Association; and T. G. Marriott, the Asphalt Roads Association.

Third Question.—The construction for roads in new countries, such as Colonies and undeveloped regions.—Major Robert Bruce, M. Inst. C.E., Chief Engineer, Perth–Inverness Road, Inverness; Lt.-Col. R. W. Butler, A.M. Inst. C.E., Divisional Road Engineer, Ministry of Transport; and Messrs. A. J. R. Hope, C.I.E., nominated by the High Commissioner for India; J. W. Spiller, M. Inst. C.E., nominated by the Crown Agents for the Colonies; and S. H. Warren, A.M. Inst. C.E., County Surveyor, Norfolk County Council.

Fourth Question.—Ways and means of financing highways (*a*) Road Construction; (*b*) Maintenance.—Messrs. Arthur Collins, Westminster, S.W. 1; and W. Rees Jeffreys, Roads Improvement Association.

Fifth Question.—Highway transport; correlation and co-ordination with other methods of transport; adaptation to collective and individual requirements.—Sir Henry P. Maybury, G.B.E., K.C.M.G., C.B., M. Inst. C.E., Chairman, London and Home Counties Traffic Advisory Committee; and Mr. E. S. Shrapnell-Smith, M. Inst. T., Past President, Commercial Motor Users Association.

Sixth Question.—(1) Traffic regulation in large cities and their suburbs; traffic signals—design and layout of roads and adaptation to traffic requirements in built-up areas; (2) parking and garage of road vehicles.—Alderman W. G. Davie, J.P., Messrs. F. L. D. Elliott, Assistant Commissioner, Scotland Yard, London, S.W. 1; T. Peirson Frank, M. Inst. C.E., F.S.I., City Engineer, Liverpool; J. S. Pool Godsell, Secretary to the London and Home Counties Traffic Advisory Committee, Ministry of Transport; Parker Morris, LL.B., Town Clerk, Westminster City Council; G. L. Pepler, F.S.I., Chief Town Planning Inspector, Town Planning Department, Ministry of Health; and Sir John Pakeman.

THE special Commissioner of the *South African Mining and Engineering Journal* in Rhodesia says that the latest highly favourable developments point certainly to 100 miles at least of big copper mines in Northern Rhodesia. The Wanderer Mine commences crushing at the end of August, and the New Mayfair plant is running smoothly. The new rock plant at Shabani has started satisfactorily, and a pilot plant at Alaska is under erection.

CAIRO MAIN DRAINAGE—AMI

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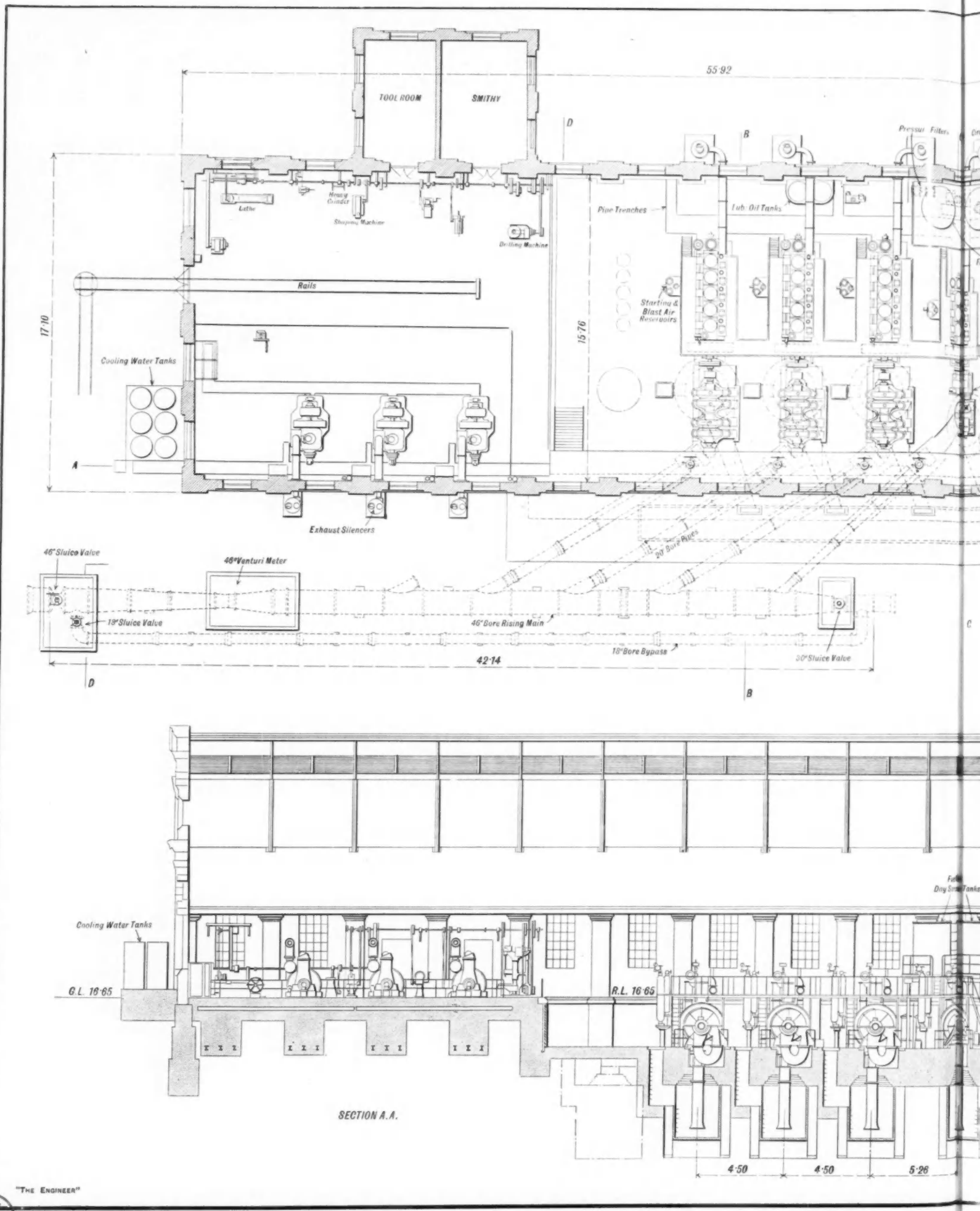

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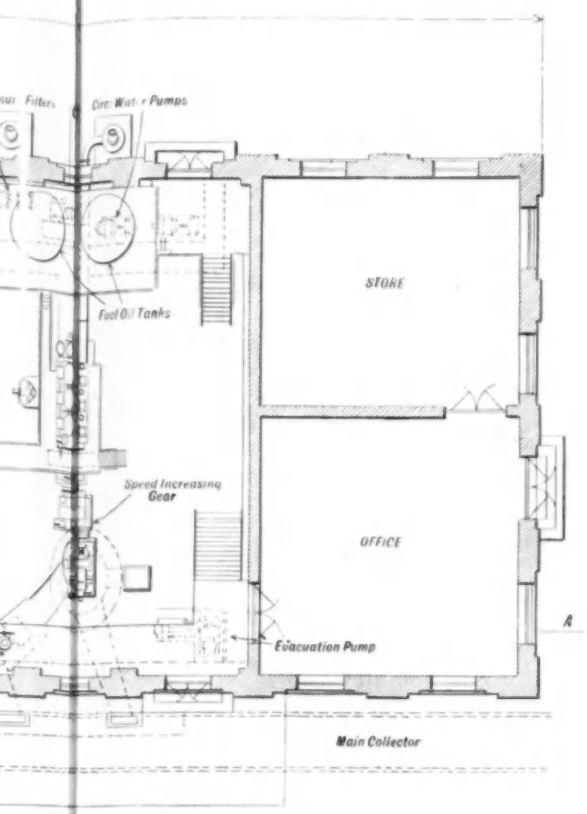

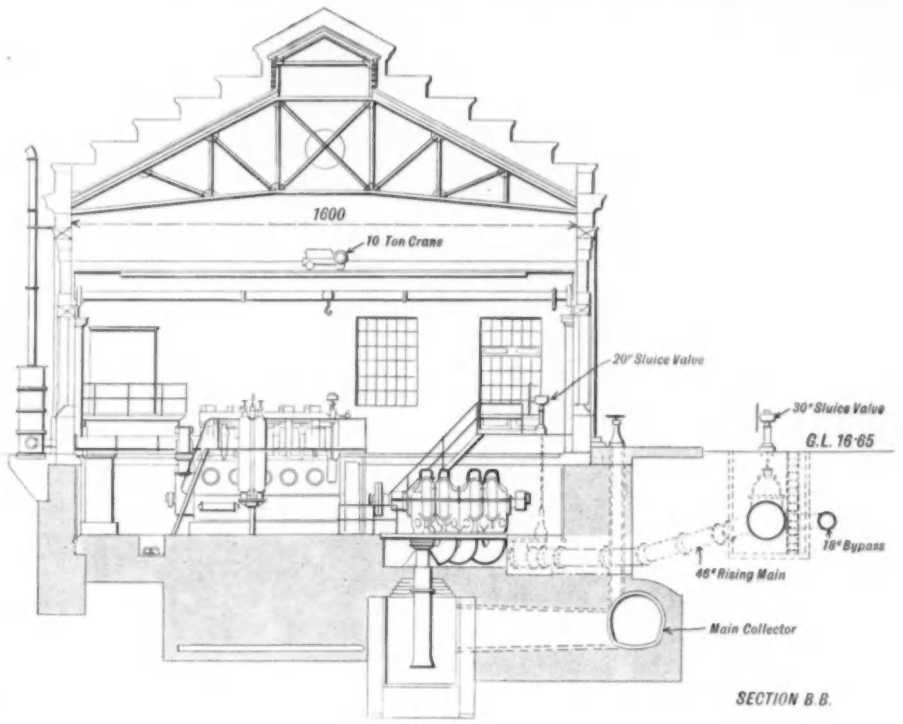

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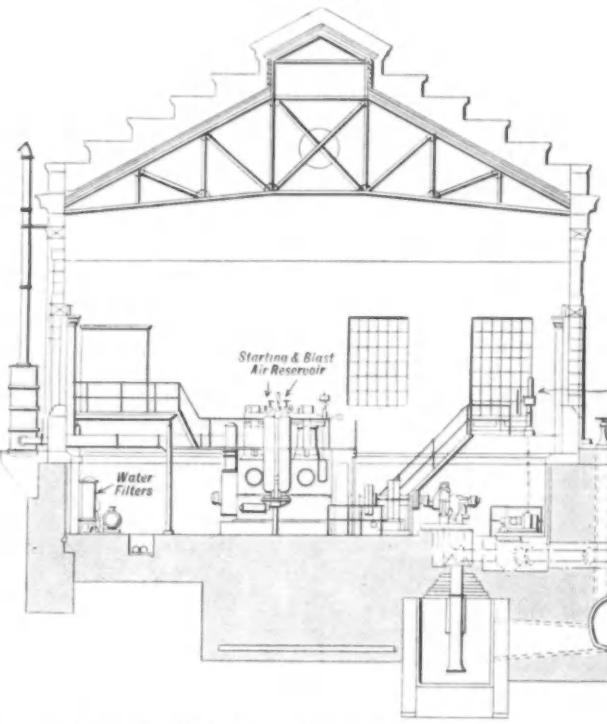

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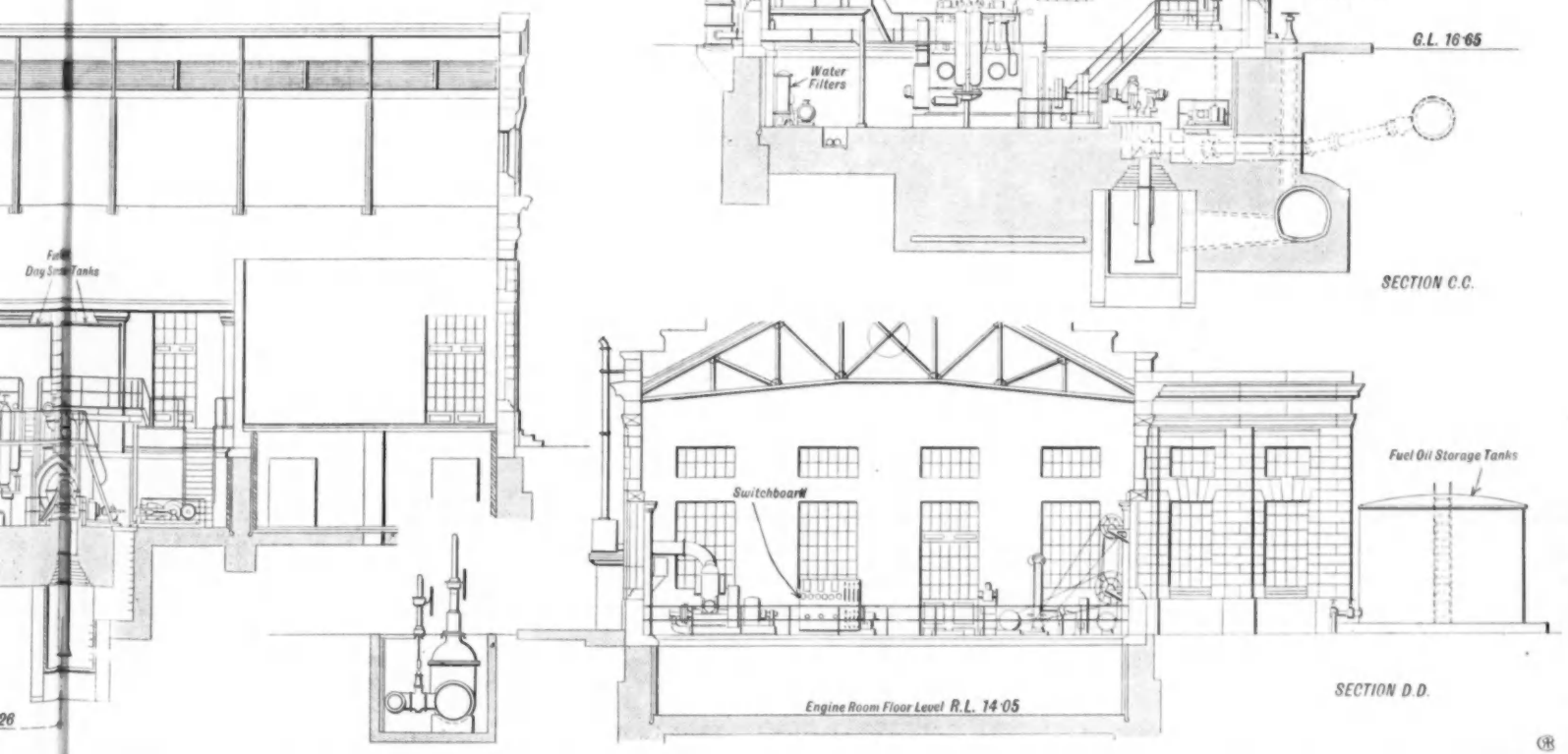

SECTION D.D.

MIN. OF AGRIC.

Railway and Road Matters.

THE Campbeltown and Machrihanish Light Railway is a line of 2ft. 3in. gauge, 6¼ miles long, which was opened in August, 1906. The capital was raised locally and in Glasgow, but the control has now passed to the British Trust and Banking Company, which has purchased 90 per cent. of the issued share capital.

ON Sunday, June 9th, a steam rail car from Staddlethorpe to Doncaster was run into by an excursion train from Leeds to London at Marshgate Junction, Doncaster. The circumstances were inquired into by Colonel Anderson on June 19th, when the driver of the rail car admitted that he was warned at Barnby Dun, 3 miles in the rear of the junction, but over-ran the signals.

SOME time ago Belgium decided to adopt Westinghouse brakes as standard for its goods wagons. It is now announced that draft contracts for the supply of such brakes have been approved by the Administrative Council of the Belgian National Railway Company, whereby the Westinghouse firm is to supply a considerable quantity of such brakes, while the remainder will be obtained from Germany on account of reparations.

THE Canadian National Railways have recently issued a list of extraordinary accidents on the railway caused by the carelessness of motorists. The driver parked his car on the line whilst he had a sleep; one tried to drive between two sets of wagons that were shunting; seven drove along the railway and met trains; twelve parked too near the line; forty-four drove into the sides of moving trains; and thirty-eight into the sides of standing trains.

THE Roads Improvement Association has prepared a sign to warn motorists of points where the margin between tramcars and the kerb is insufficient for the passage of another vehicle. The words "Narrowing Margins," surmounted by a red triangle and two red lamps of a distinctly tapering shape will be the sign. Such a point occurs on the Middlesex side of Putney Bridge, where the southbound tram line suddenly passes from the centre of the main road to the side of the kerb.

THE articles of association of the Argentine railways are to be so altered that the ownership of shares by aliens—*i.e.*, not of British or Argentine nationality—shall not exceed 20 per cent. The intention is to avoid control by financial groups of other countries in order to obtain orders for plant and equipment. As out of nearly nine millions at present invested in the Central Argentine, for instance, less than one million is alien-owned, it is not thought that the proposed restriction will inflict any hardship.

IN a letter that appeared in *The Times* of June 29th, Colonel Pickard, of the National Safety First Association, gives some figures as to the number of accidents in which motor vehicles were concerned, reported by the Home Office in respect of the number of such vehicles, as reported by the Ministry of Transport. The ratio has grown from 44·9, 46·0, and 49·2 in 1921, 1922, and 1923 respectively, to 54·3, 53·4, 53·2, and 55·5 in 1925, 1926, 1927, and 1928. The improvement noticed in 1925 was coincident with the issue of the safe-driving pamphlets of the Association in that year.

THE completion of the east-west transcontinental railway of the Australian Federal Government was followed by an agitation for a similar north-south railway, but for a long time, owing to the greater extent of barren territory, the route could not be agreed upon. Eventually, it was decided to build the new line from Oonadatta by Alice Springs. According to a cable from the Adelaide correspondent of *The Times*, the first train to reach Alice Springs—which is as far as the line has as yet been sanctioned—arrived there on June 27th, and the railway is to be officially opened on July 14th.

THE early retirement is announced of Mr. H. J. Wynne, the signal and electrical engineer to the New Zealand Government Railways. Before going to New Zealand some twenty-eight years ago, Mr. Wynne was the signal superintendent to the Highland Railway, where, about four years previously, he had succeeded Mr. W. Young. The new signal and electrical engineer in New Zealand is Mr. G. W. Wyles, who has been Mr. Wynne's assistant for thirteen years. Mr. Wyles was formerly in India, and is the son of the late Mr. F. W. Wyles, who was the assistant telegraph superintendent of the London and South-Western Railway.

THE successor to Sir Felix Pole in the position of general manager to the Great Western Railway is Mr. James Milne, who assumes his new office on July 8th. Mr. Milne has had a very varied career since he joined the Great Western in 1904, and has been in the locomotive, superintendent of the line, and general manager's departments. He entered the last in 1922, and has successively been assistant and principal assistant to the general manager and assistant general manager. Outside railway service, he was for over two years, after the Ministry of Transport was formed, a director of statistics there, and in 1922 was one of the financial authorities who assisted Lord Incheape on the Indian Retrenchment Committee.

THE Institution of Railway Signal Engineers has just held its summer meeting in Holland. Except in one respect, there is little to learn from the signalling methods to be found in that country, but the exception is the important one that all the points, as well as the signals, are actuated by double—one outward and a return—wires instead of by rodding. Many features in Dutch signalling appear to be contrary to British ideas, but in every detail there is consistency. In the distant, or cautionary, signal the arm, when "on," is not horizontal as here, nor is a red light exhibited as was our custom until quite lately. The Dutch railways retain the white light to indicate "clear." That practice is usually regarded as obsolete on the ground that a white light could be given through the red glass having fallen out or from a nearby street lamp or a house. It is, however, represented that the drivers are educated to observe the position of the arms at night as well as the lights; that sea mists are of frequent occurrence, and so the yellow light used elsewhere is not then so efficient; that white can be seen further than green, and that the green light can be reserved for a definite "caution" indication.

Notes and Memoranda.

A GOOD record is claimed by the No. 1 coal mine of the Colorado Fuel and Iron Company, in that during the period between July 27th, 1915, and March 1st, 1928, there was not a fatal accident. The mine employs 216 hands, and 2,300,000 tons of coal were mined.

WHITE lead and chrome yellow are being made direct from galena ore by continuous chemical processes in the experimental plant of the General Reduction and Chemical Company, Newark, New Jersey. A considerable amount of British capital is invested in the business.

ON June 26th the centenary occurred of the death of James Lewis Smithson, who by his will, dated October 23rd, 1826, left his fortune "to the United States of America to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men."

THE two new pumping stations for supplying Benares with water from the river Ganges are being supplied with machinery by the General Electric Company (India), Ltd. At the lower station there will be two vertical slip-ring motors of 700 horse-power, and at the upper station there will be four horizontal motors with an aggregate output of 1100 horse-power.

THE rapid expansion of the telephone system in the United States is illustrated by figures recently published in the report of Washington Federal Census Bureau. The number of telephones has increased during the past five years by an average of 5·8 per cent. per annum, while the population has increased at the average rate of 1·50 per cent., so that the rate of telephone increase has been nearly four times that of the increase of population. Florida, with 103·7 per cent., shows the largest rate of increase over the period, a gain attributable to real estate development between 1922 and 1925. California ranks second with an increase rate of 57·9 per cent. New York State shows an increase of 45·8 per cent. The total number of telephones in the United States at the close of 1927 was 18,522,767, or one to about every six of the population.

SPEAKING at the recent High Tension Conference held in Paris, Mr. Borlase Matthews described a cheap form of overhead line construction adopted on his farm at East Grinstead. Instead of the usual tree trunk with the bark stripped and coated with a preservative, Mr. Matthews uses two pieces of ordinary sawn timber which are bolted together at the top so that they form the letter X. At every quarter of a mile and at bends slightly stouter anchoring posts are erected, but for other portions of the line these simple "X" supports are employed. By means of two 2ft. lengths of iron piping, the supports are set in concrete blocks, which serve as footings, and the possibility of the wood rotting at the ground level is thus avoided. Excluding the cost of wires and wayleaves, the cost of this form of construction is said to be rather less than £70 per mile. Two men can erect the supports.

ACCORDING to General Hsiung Bin, Director of the Aviation Department of the Chinese Ministry of War, while the first "home-made" aeroplane, the "Cheng Kung No. 1," may not be said to be comparable to foreign planes of similar type, nevertheless it proves that such planes can be produced in China instead of being imported from abroad. "Such a plane," Director Hsiung points out, "is quite serviceable for practice flights and a few more will be immediately built for the purpose, for what we need most at present is competent aviators." Continuing, General Hsiung said that the Central Authorities are considering the reopening of the Aviation Institute at Peiping to accommodate at least 300 students. The building and equipping of a modern aeroplane factory, at an estimated cost of 5,000,000 dollars, is also under contemplation.

THERE is a very extensive literature on the subject of the effects of temperature on the setting times and strengths of cements and concretes, but the mass of data available is confused and un-coordinated. The Building Research Station of the Department of Scientific and Industrial Research accordingly experienced difficulty in dealing with numerous inquiries received for information on these matters. It was found necessary also to attempt some condensation before the data could be of service in connection with the research work in progress. Dr. W. N. Thomas undertook the laborious task of summarising the literature, and Mr. Davey has carried out some experimental work in an attempt to clear up a number of disputed points. It is thought that Dr. Thomas's critical survey, which has just been issued by H.M. Stationery Office, price 1s., will prove of value to all users of cements and concretes.

IN his comments on the explosion of a vertical boiler, used in a stable, the Engineer Surveyor-in-Chief to the Board of Trade makes the following remarks: The owner of this boiler purchased it in 1919, apparently without obtaining any information as to its previous history, and continued to work it intermittently at the pressure fixed by boilermakers who were employed to inspect it and to give the certificates required under the Factory Acts. The owner might reasonably expect that men who professed to be able to make and to repair boilers would be competent to ascertain the safe working pressure of the boilers they have inspected. Unfortunately, this expectation was not justified, as the report following the last inspection stated that the boiler was in a safe working condition for a pressure of 50 lb. per square inch, and when the explosion took place a few months later the fire-box was found to be so seriously wasted that it was then fit for no useful working pressure, and must have been in that condition for a considerable time. The inspector on this occasion admits that he had had no previous experience in such work, and did not possess the knowledge necessary to enable him to fix a safe working pressure for a boiler. Wastage of fire-boxes at the part which actually failed in this boiler is so common that any experienced man, even without any theoretical knowledge, would have been careful in the case of a boiler which was evidently of considerable age, and had been worked under unfavourable conditions, to ascertain definitely the thickness of the bottom part of the fire-box plating, and that can only be found satisfactorily by drilling.

Miscellanea.

IT is proposed to put up a salt factory at Karachi, India.

A FACTORY for the production of stainless steel and other alloy steels has started work at Shawinigan Falls, Montreal.

A WELL drilled to a depth of 3200ft. in the Chatham District of Ontario is reported to be producing 5,000,000 cubic feet of gas daily.

THE new air-port at Hamilton, Ontario, covers an area of 200 acres. Accommodation has already been provided for twelve aeroplanes.

A NEW industry has been started in Canada, in the form of the collection of shells for the manufacture of lime, in Hamilton Inlet, Labrador. The supply of shells is said to be practically inexhaustible.

THE Canadian Government is arranging for the dispatch of fifty parties, with a total *personnel* of 250, for the purpose of geological surveys during this summer. The field to be covered ranges from the Yukon to Nova Scotia.

A DEMONSTRATION of the harnessing of British coal products to agricultural power purposes took place on Wednesday, June 26th, at Belmore Farm, Hayes, Middlesex, when "Coalite" was used in a producer-gas plant fitted on an agricultural tractor.

THE dinner of the Whitworth Society was held at the Engineers' Club, Albert-square, Manchester, last week, the chair being taken by the President, Mr. Fred H. Livens (Wh. Sc., 1874), who inducted into office the new President, Mr. William H. Fowler (Wh. Sc., 1873), of Manchester.

ARRANGEMENTS have been made for the construction of another dam on the Mattawin River, one of the tributaries of the St. Maurice, Quebec. It will provide 100,000 horse-power in addition to the plant already installed on the river, which, it is estimated, will ultimately produce 1,500,000 horse-power.

THE first section of the new lighting scheme of the Thames Embankment was switched on, on Saturday evening, June 29th. It employs lanterns, suspended at a height of 30ft. from the ground, and at intervals of 140ft., each equipped with a 1500 watt Osram gas-filled lamp and prismatic glass refractor.

IT is said that the grain-carrying vessel which is about to be launched at Lauzon, Quebec, for the Canadian Steamship Lines, will be the first ship of this kind to be equipped with Diesel machinery. She will be capable of carrying 100,000 bushels of wheat, or some 5000 bushels more than any other 14ft. draught boat, and will have main engines of 800 horse-power. She is 252ft. long by 43ft. beam and 20ft. 6in. moulded depth.

THE members of the French Society of Civil Engineers who are making a tour of Great Britain, arrived in Birmingham on Monday, where they were welcomed by members of the local sections of the Institutions of Mechanical, Electrical and Civil Engineers. During their stay the visitors were conducted over the Hams Hall generating station by the city electrical engineer, and paid a visit to Messrs. Cadbury's factory at Bournville.

WE are informed that the Patents Committee, under the chairmanship of the Rt. Hon. Sir Charles Sargant, has begun its investigations; and persons and associations who wish to submit suggestions or to give evidence before the Committee are invited to communicate with the Secretary, Mr. R. W. Luce, Industrial Property Department, Board of Trade, 25, Southampton-buildings, W.C. 2. The Committee was appointed by the Board of Trade to report whether any amendments in the Patents and Designs Acts, or changes in the practice of the Patent Office, are desirable.

H.M. TRADE Commissioner at Calcutta reports that motor vehicles registered in the City of Madras for the quarter ended March 31st, 1929, numbered 334, made up as follows:—Cars, 264; taxis, 7; omnibuses, 55; and lorries, 8. The Commissioner in East Africa reports that 346 new motor cars were registered in Tanganyika during the year 1928. According to statistics received from the Colonial Office, 4865 private cars and 1540 motor trucks and omnibuses are in use in the Falkland Islands as at December 31st last. The Officer in Charge of Commercial Affairs at Teheran reports that 4104 private cars and 2174 trucks and omnibuses were in use in Persia as at January 20th, 1929.

A PAPER has been issued on the examination of the "reactivity" of coke, "reactivity" being measured by the amount of carbon dioxide reduced when the gas is passed over heated coke under standardised conditions. The paper gives the results of determinations on some seventy-eight metallurgical cokes, and a comparison with the "shatter indices" of the cokes. It is shown that a broad, but not detailed, correlation exists between the reactivity value and the physical strength of the coke. Indications are also given as to the effect of the conditions of carbonisation and of the inorganic constituents of the coke. The investigation is proceeding, and further results are required before definite conclusions can be drawn from the results obtained. The work has been carried out in co-operation with the National Federation of Iron and Steel Manufacturers, which has contributed to the cost. The paper can be obtained from H.M. Stationery Office, price 1s.

IT was announced by cable on Friday last, June 28th, that the conversion of the American engineering and finance firm of Stone and Webster Inc. into a public company had been completed. For forty years the firm controlled and managed enterprises international in scope. It built power stations representing about 10 per cent. of the total installed central station capacity of the United States, and under its direct operation or supervision there are sixty public utility properties in the United States, Canada and the West Indies, with a combined aggregate market value of over £100,000,000. The constructional activities of the firm included the building of power stations with an aggregate steam and hydro-electric capacity of over 4,000,000 horse-power. On constructional projects of other kinds the company spent over 1,000,000,000 dollars (£200,000,000) in the past twenty-five years, and work still to be completed on these contracts will absorb over 100,000,000 dollars (£20,000,000).

CAIRO MAIN DRAINAGE—AMIRIA PUMPING STATION

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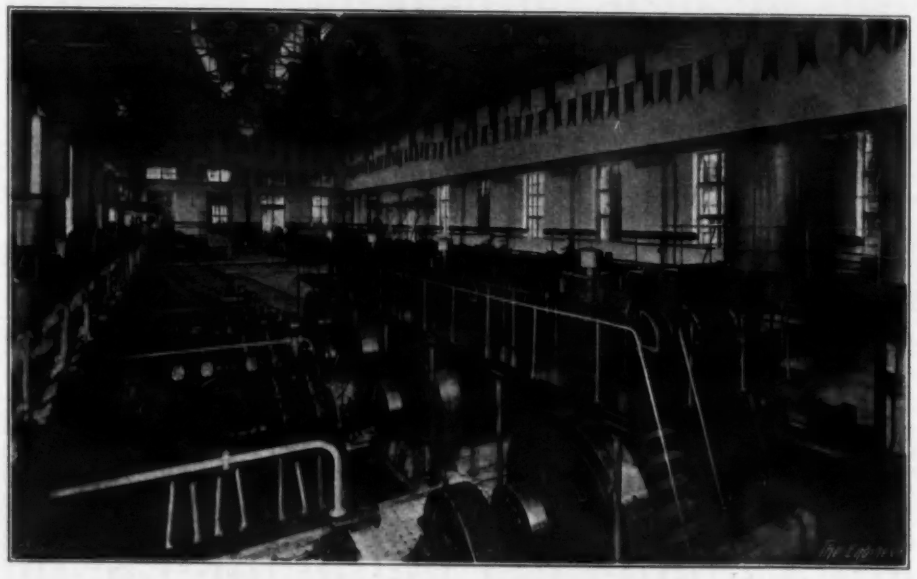

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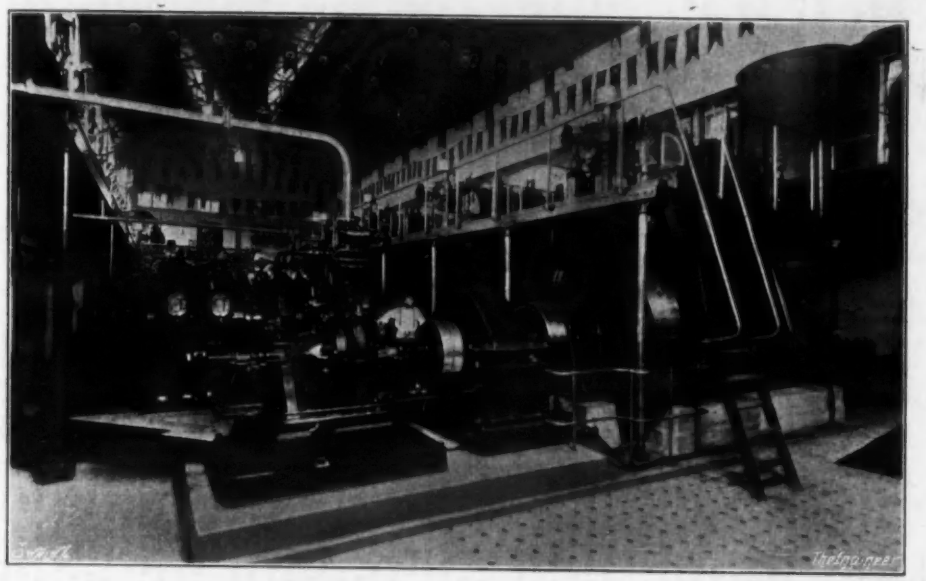

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NOTICES TO READERS.

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THE ENGINEER.

JULY 5, 1929.

The International Steam Tables Conference.

THE International Steam Tables Conference, which will be held next week in London, has a task before it of which the difficulty is only comparable with the importance. The object of the Conference is, in short, to pave the way for the publication of a set of steam tables which, being endorsed by the highest authorities in every country, shall be internationally accepted as representing the most exact knowledge yet available as to the properties of steam. This is a consummation devoutly to be wished. For fifty years or so, there was international acceptance of the masterly work of Regnault, which sufficed for the needs of engineers till about the end of the last century. Round about this time, numerous investigators, particularly in Germany, contributed fresh data on various points, but the greatest advance since the days of Regnault was the development by Callendar of a set of simple equations, so linking up the properties of steam that all could be computed from a comparatively limited number of experimental results. Callendar's equations were presented to the Royal Society in 1900, but unfortunately were not brought to the attention of engineers at the time. Dr. Mollier, in Germany, however, realised their importance, and published the first steam tables based upon them in 1906. So far as British engineers were concerned, of the half-dozen or more different tables available, preference was divided until a few years ago between the American tables of Marks and Davis, published in 1909, and the tables issued by Callendar himself in 1915. The former were the fuller and more convenient for every-day use, but the authors had neglected Callendar's teaching on thermo-dynamic consistency, and when it was discovered that it was possible to derive from their tables two different values for the same quantity, the tables were self-condemned as inaccurate. This left the Callendar tables, which were essentially self-consistent, alone in the field, and they became the only tables recognised in Great Britain for serious work. In 1924 they were much improved in form and extended from their previous limit of 500 lb. pressure to a pressure of 2000 lb. and a temperature of 1000 deg. Fah., thus providing data for almost any steam conditions a designer was liable to be faced with. Workers in other countries had not, however, been idle in the meantime. With characteristic energy and enthusiasm, the Americans set out to settle the steam table question once for all, and for eight or nine years past the laboratories of the Bureau of Standards, Harvard University, the Massachusetts Institute of Technology, and the General Electric Company of Schenectady, have all been collaborating in a comprehensive series of investigations under the auspices of a Committee of the A.S.M.E. In 1926 the A.S.M.E. published in their monthly journal, *Mechanical Engineering*, a new entropy chart extending up to 750 lb. pressure, and an elaborate table of specific volumes up to 1200 lb. pressure. These, it was explained, were not to be regarded as the last word of the investigators on the subject; but as it was clear that finality was being approached, the desire was felt in many quarters that finality for one country should be finality for all. Hopes raised at the World Power Conference last year that no responsible investigators in any country would publish further tables until an effort at least had been made to secure international agreement, were disappointed by the appearance a few months afterwards of a second American entropy diagram, extending to the critical pressure and accompanied by a new table of specific volumes up to 3500 lb. pressure, but with figures unhappily differing throughout from those of its predecessor of three years before. This publication was all the more unfortunate, not only as the figures are likely to need another revision in the light of Callendar's recent discoveries regarding the true nature of the critical point of steam, but also because it necessarily brought about the issue by the Institution of Mechanical Engineers of Callendar's own extension to his tables, and thus made confusion worse confounded.

We mean no disrespect to the very important work done in Germany, Czechoslovakia, and elsewhere, if we confine ourselves at the moment rather to the English and American efforts to provide a correct set of steam tables. Callendar started from his determination of the adiabatic index of expanding steam carried out at McGill University in 1897. By a simple and ingenious method of experimenting, devised by himself for the purpose, he decided that the index was constant and equal to 1·3, and this value he has never seen cause to modify. To those who think that accuracy is only compatible with a long string of figures behind the decimal point, the number may seem too simple to be more than an approximation. Yet it has stood the strain of endless calculations made during the last thirty years, and being still accepted by its author, and having been verified by Eichelberg in Germany up to 300 lb. pressure, it stands as an outpost of the Callendar tables. The Americans do not base their tabulations on the adiabatic index, and so far as we know have made no attempts to determine its value. Yet there is such a function, constant or otherwise, and working it out from the American specific heat tables, its value, according to them, is found to be lower than the value given by Callendar. Here, then, is a definite point of difference which should be capable of settlement one way or the other by experiment. If Callendar's figure is found to be correct, or so nearly correct that its departure from accuracy leads to no sensible error in computations, his work will receive strong confirmation. If, otherwise, we shall have at least an internationally agreed value for the adiabatic index, which will serve as a starting point for further agreement. Another kind of experimental determination, which is fundamental both to the American and the Callendar tables, is the Joule-Thomson cooling effect observed when steam is allowed to expand through a porous plug. The American tables are, indeed, based primarily on the results of porous plug experiments, conducted by Dr. Davis and Dr. Kleinschmidt, over a large range of pressures and temperatures. Since the Joule-Thomson effect is of quite equal importance in the Callendar tabulations, it has been measured with great accuracy for the purpose of these tabulations, and it is absolutely necessary that the same values should be accepted on both sides of the Atlantic if agreement is to be reached in the matter of steam tables. Here, then, is another point which must be cleared up, if necessary by further experimental work. One could continue to give examples of figures amenable to direct experiment which must be accepted by all parties before real progress can be made with regard to tabulation. Among them must not be forgotten the mechanical equivalent of heat, recently stated by the American Bureau of Standards to be slightly

greater than the generally accepted value. All matters of this kind are merely physical facts, necessary to the production of steam tables, but not determining in any way the nature of the formulæ to be used in computing them. Provided that the formulæ are thermo-dynamically consistent with each other, and that each agrees well with such facts as can be observed, it might be thought that one was as good as another. There are, however, other considerations to be taken into account. Some facts can be determined experimentally with much greater ease and certainty than others, and it is therefore very important that the formulæ should be based on easily verifiable data rather than on observations about which doubt can exist. Furthermore, a formula which represents as closely as possible the molecular conditions which the theory of gases makes probable must always be given the preference over any purely empirical expression which happens to fit fairly well with plotted observational points. Finally, a practical test of a good formula is its simplicity and the consequent ease with which it can be used for calculations. Judged by any or all of these standards, Callendar's formulation of the properties of steam has very high merits. One has only to compare his expression for the total heat of steam, for example, with that devised by the American workers, to remark the difference. Since the old objection that Callendar's formulæ could not represent the conditions at the critical point has been removed by the discovery that the conditions there are not at all what they were believed to be, and that when the higher degrees of molecular aggregation are taken into account, the formulæ agree very well with the true facts, his theory has received exceedingly strong support. Indeed, unless some modification is found to be needed in the fundamental physical constants at the base of his work, it is hardly likely that further research can necessitate any material change in his tabulation of the properties of steam.

We do not, however, wish to anticipate in any way the decisions of the International Conference. The members are unlikely to waste their time—for it would be only a waste of time—in discussing the rival merits of different steam tables at the present juncture. The work which is to their hand is the agreement on physical constants, in the first place, and then on certain other crucial figures which enter directly or indirectly into the composition of all steam tables. How far they can get, even with such a limited programme, is doubtful. But they can at least decide what figures are crucial, and what further work must be undertaken to secure agreement concerning those about which there is any doubt. Several conferences are likely to be needed before enough agreed data are collected to make it worth while to raise the controversial question of the best way of embodying the data in formulæ. By that time, indeed, the question may have lost its significance. For with all table-makers using the same data, the formulæ they adopt can be left to their personal preferences, the final results being identical if the mathematics and thermo-dynamics are correct. The initiative of the British Electrical and Allied Manufacturers' Research Committee, in convening the Conference, is worthy of praise, and the ready response by the workers in other countries is a good augury for the eventual appearance of what all steam engineers so earnestly desire—a set of International Steam Tables.

An Ideal for Engineers.

THERE was a short letter by Captain George S. C. Swinton on Charing Cross Bridge in a recent number of *The Times*. It ended with these sentences: "We all would like beauty, but, for the well-being of London traffic improvement is a paramount necessity. If we really set to work it should not be impossible to achieve both in combination. But we must be imaginative." In the days when Charing Cross, and many another bridge across the Thames, was built, no one stopped to think of such a combination. If a through bridge on ugly cast iron columns would take trains over the river just as well as a handsome structure, then it "was the one for his money." Serviceability was the sole consideration. Ruskin might preach beauty and write about it till his quill was worn down to the feather, but beauty was not an affair for engineers. They took their stand upon the absurd doctrine that complete fitness for the destined purpose resulted, inevitably and automatically, in the attainment of beauty. The idea that beauty had a value of its own was quite incomprehensible to the greater part of the population of the kingdom. The sense of dignity which inspired much of the earlier work of the railway builders had gone. Steel and iron were replacing stone and brick, and no one knew how to make beautiful structures in the new materials, and no one cared whether they were pleasant or not to look at, provided that they served their purpose and cost little.

But railway bridges did not stand alone. It was accepted by the public as an axiom that the works of the engineer must be ugly or offensive—by dirt and dust and noise. Some few people railed against them in all their forms, but the world as a whole shrugged its complacent shoulders and said that if it had the advantages it could do without the beauty and could put up with the inconveniences. It is only quite recently that a general spirit of discontent has begun to move. The world is getting just a little too much mechanisation. What it accepted willingly and proudly a few years ago it now regards as another intolerable improvement of our civilised lot. It accepts, but with grumblings. No man refuses to go up by a lift because it has noisy gates or to use electricity because chimneys belch black smoke. We all condemn sin, but how many of us would refrain from warming our hands at the Devil if he came up to earth surface on a cold day? Yet in that case we would have an option; in the works of the engineer we have none. It is quite impossible to escape them. The advantages they confer are so numerous and so manifest that we cannot do without them. We must have them for our very existence. But is there any reason for having all kinds of ugliness with them? We believe not. Cannot we, as Captain Swinton suggests, combine beauty and usefulness? We are quite certain that that desideratum can be attained. By ugliness we mean not only things that offend the eye, but those that offend the ear and other senses, or that do damage by the destruction of desirable things—material or spiritual. For many years a struggle, far from hopeless, to improve the atmosphere of big cities and to prevent the pollution of rivers has been carried on. More recently, the reduction of street noises has won attention. In the factory itself an enormous improvement has been effected, not only in matters which affect the health of workpeople, but in others that provide for their cleanliness. Contrast the condition of our underground railways of to-day with that of thirty years ago, or the comforts and relative decency of a modern Channel steamer with the state of the Channel packets in Dickens' time. When the engineer sets himself down to get rid of the ugliness that is naturally associated with a great deal of his work, he invariably succeeds. It can be done; it needs but the will to do it.

To give all the unquestionable services which the engineer can render and yet to remove from them everything to which objection may be taken is a high ideal, but one that is well within the limits of attainment in all save a few cases. But, as Captain Swinton says: "We must be imaginative." The workers of Sheffield and the Black Country or the miserable mining valleys of Wales cannot see beyond the conditions which have prevailed since the days of their grandsires. But the imaginative man may picture industrial areas robbed of their grime and pall of smoke, and the workers housed in healthy and pleasant surroundings. It is to him we must look for inspiration to lead us to the realisation of better things. Just as scientists agree that the existence of an hypothesis is valuable in directing research, so the existence of some ideal of cleanliness, quietness, and beauty is necessary to inspire engineers, and more necessary still, in many cases, in those who employ them.

Literature.

The Story of the Baltimore and Ohio Railroad, 1827–1927. By EDWARD HUNGERFORD. New York: G. F. Putnam's Sons.

History is the most difficult of all literary arts, since it demands not only style, but diligent research into the smallest matters, and a sound judgment. The historian who describes only little things will bore his readers; if he deal only with great things he will deceive them, since all great things have their origin in little. —CARDANO (1501–1576).

THIS remarkably readable and attractive book deals with the origins and development of a great railway, in every phase of its existence, and from all aspects—economic, technical, social, and political; in peace and through war.

The author's widely embracing synopsis gives therefore a complete picture of a vast human undertaking and accomplishment which is a contribution to the history of universal man. And it is doubly opportune. From this picture a forgetful public, intoxicated with the unbridled triumphs of petrol on the common road, and almost persuaded that railways are, and always have been, a hindrance to efficient transportation, may learn of their immense contribution to national well-being, and may perhaps understand the pride with which a past generation often regarded them.

But even more opportune and valuable to-day is a history which—whether by intent of its writer or by logical emergence of facts—reminds us of fundamental similarities, rather than of the differences, between the Englishman of a hundred years ago and the Americans who largely formed the spiritual and intellectual core of the early United States after the breach with England.

The reader is tempted to find in Mr. Hungerford's early chapters support for the popular thesis that the world would have been a more peaceable and comfortable place had its politics been directed by such men as planned and promoted its railways. His chapters on the Civil War challenge such an easy conclusion, but at least his "Story of the Baltimore and Ohio Railroad" shows that within ten years of an intense political estrangement and bitterness, the relations between American and English men of affairs and engineers were as cordial and close as they are to-day. In 1815 in the "Westminster Play"—still the annual mirror of political thought in England—one "*Davus*," hearing that "*Geta*" proposes to emigrate to "*Hesperia*" (America), exclaims: "What! To that country inhabited by *Barbarians!* Let the ruined man, the impious wretch, praise America! If you are yet in your senses, stay at home!" Thus from the politicians, against whose calumnies an American writer* makes a dignified and reasoned protest in a volume which he dedicates in 1819 to Mr. Robert Oliver, of Baltimore.

In 1827 we find this Mr. Robert Oliver, as one of the leading citizens of Baltimore, among the signatories to the demand for a railway charter from the State of Maryland; and ten years later the promoters send a deputation to England for practical advice. So much for the business men and engineers who appear first in "The Story of the Baltimore and Ohio Railroad"! Who, then, were these "barbarians"—as the politicians called them? Men of like passions with contemporary Englishmen, and with precisely the same motives and qualities of courage; of that they had plenty, perhaps it was "the vaolur of ignorance," to quote the phrase of another American writer. Anyhow, Mr. Hungerford thinks that though these worthies of Baltimore had vision, it was as well they had not too much—it might have appalled them from their task. They did see difficulties enough, but the quiet confidence of a leading Quaker, Philip E. Thomas, persuaded doubters, just as that of Edward Pease eventually established the Stockton and Darlington Railway. It is interesting to compare the published portraits of the two men as they are given in Mr. Hungerford pages and in "A Century of Locomotive Building," by Robert Stephenson and Co.

The analogy across the water strikes one on many pages of the story, particularly at the beginning. Where analogy fails is in the scale of the undertakings. The men of Baltimore had to save the future for a town of 80,000 inhabitants threatened with a diversion of an important source of wealth. They had to maintain and enlarge its position as a port or *entrepôt*, by a strategic move which would involve crossing the Alleghanies to reach the Ohio River, a total track of many hundreds of miles. All this is told dramatically enough by the author in his own graphic style. We have found something of the kind in the recent writings of another American historian—it is perhaps the by-product of the age of "movies"; at least, it is highly pictorial. We do not criticise.

One omission from the book we regret—the absence of sufficiently detailed maps to enable us to follow the phases of the long struggle between rival canal and railroad interests which fill so many pages. And surely the omission of proper contour maps, in particular, from the history of a railway is one which future writers should remedy. We do not refer alone to Mr. Hungerford's railway history. Almost all fail in this respect. Railroad promoters have to think, and their engineers have to act, in three dimensions, of which the vertical may be the most important, decisive of final success or failure. Gradient appears again and again in the story, sometimes even threatening defeat and always involving vast expenditure, increasing as the enterprise proceeds to its goal.

But we must return to the beginning. The immediate business to be faced, in the attempt to ensure the commercial future of Baltimore, was whether to promote a canal or a railroad. On the report of a Committee, which reads like an English State document, the railroad carried the day, and this on evidence obtained from England. It had already been decided that no extension of the turnpike road would meet the particular hopes and intentions of the men of Baltimore, though the National Turnpike system of the United States at this period was in an advanced state. But already it was being found inadequate, and we have a striking picture of a state of congestion which travellers remembered with relief and horror when they had overcome it. "Whiskey at 3 cents a glass" was a contributory cause, no doubt, of the conges-

* Robert Walsh, jun., "An Appeal from the Judgments of Great Britain," &c. Philadelphia, 1819.

tion—as it was to later constructional troubles on the railway—and Mr. Hungerford finds here some of the roots from which Prohibition was to spring three generations later.

And there were all the other troubles from conflicting human interests, and temperaments, and policies, stultifying technical skill and wasting effort till one wonders again and again whether man is not even more the obstacle than the instrument of his own progress; his stupidity the steepest height he has to scale. It has been much the same way in England, but in Baltimore the scales were to be weighted by State interest in the canals and inter-State jealousies which time and again threatened to ruin or cripple the whole project. In 1843 a rival railway scheme to prevent access by the Baltimore and Ohio to Pittsburgh was smuggled through the Pennsylvania Legislature, among the "Other Purposes" of "An Act for the Relief of the Overseers of the Poor"!

State influence pursued the construction of canals, in some cases after their economic advantages over the turnpike had definitely passed to the railroad, and the traveller on the Baltimore and Ohio to-day can see the dry results. Yet history is repeating itself, and once more the American railways are protesting against the growing activities of Government waterways subsidised out of taxes. Do we ever learn by history? Or are the lessons of experience recorded by Mr. Hungerford to be learnt again by the Sisyphus of each succeeding generation?

A similar question emerges from his pages on the construction of the railway and its locomotives. Why, having the benefit of English experience at their disposal, did the early American railroaders, of the Baltimore and Ohio in particular, prefer to try out so many things for themselves? After their great decision for a railroad they were still in ignorance in what manner to fashion it; so, having successfully laid their foundation stone—only recently unearthed and restored to a position of honour at Mount Clare—they wisely sent a deputation of engineers — Knight, MacNeill, and Whistler—to England in 1829, to inquire and report. Stephenson alone had already had more than ten years of practical railroading and plenty of troubles to teach him and his contemporaries what to avoid. Easy gradients where possible, a substantial road bed, and curves—as he told Marc Seguin—of more than 1500ft. were desirable. As for locomotives, within eighteen months of the American visit, his son Robert had produced, in the "Planet," the most successful type of the day; and Bury soon turned out a modification which some engineers considered to be better.

Mr. Hungerford tells us that the designing inspiration of America was for the moment "stunned by the influx" of "Planets" imported into that country. The Baltimore and Ohio Company refused to accept the implication, and encouraged native "mechanical wit" to pit itself against British—and here we must include not only the skill of the Stephensons but of such capable builders as Bury. Complaints of the "Planets" came from other American roads to confirm the judgment of the Baltimore Company; admittedly, the roads differed from those in England. The plain fact is that, largely for financial reasons, they were far inferior, and a fixed wheel base of actually little more than gauge width proved fatal to the success of the English locomotives!

There were later on other obvious reasons for the adoption of American rather than English designs. These were national pride and the claims of American builders—psychological and economic motives which every Englishman will respect, and finally the disastrous financial crisis of 1837; but the whole question of these early engines in America requires a critical examination in the perspective of history, which it has not yet received. In 1833 Robert Stephenson, referring to American objections to his locomotives on account of their weight, writes to Robert Stevens, of Hoboken, N.J., that "he is sorry that the feeling in the United States in favour of light railways is so general, as in England every succeeding railway is being made stronger and more substantial—small engines are losing ground and large ones are daily demonstrating that powerful engines are the most economical." (*Engineering*, Vol. 24, page 224.)

In 1838 the London and Birmingham Railway was opened with 65 lb. rails; by 1847, 82½ lb. rails were in use in the north. Yet so late as 1875 the Pennsylvania standard rail weighed only 75 lb.

Regarding the locomotives of this period, Zerah Colburn—whose articles on "Locomotive Economy" in *Engineering*, 1867, show that he was no sparing critic of English engineers—wrote of American locomotives that they were far less efficient than English. "Economy of fuel has not been studied to the same extent—the blast pipes are smaller, the draught more forced, the back pressure greater, and less expansion is attempted." The fuel consumption, in fact, appears to have been almost double that of contemporary English engines, even when burning "coal of excellent steaming quality." He also makes it clear—and this is confirmed by the evidence of Richard Roberts before the Gauge Commission in 1845—that the earlier performance of the Norris engines, imported for the Birmingham and Gloucester Railway, had been obtained by the same extravagant means and by the use of higher pressures than stated.

The very inconsistency of the complaints from various roads against the early English engines—they were both "too heavy" and "too light"—are suspicious. Many of the reports against them "savour too much of prejudice," to quote the words of the late Mr. Snowden Bell, who did much just before his lamented death to place in their true perspective the facts concerning the famous Norris engines; he soon found on the Baltimore and Ohio, as on other roads in England and Europe, to have been overrated.

To-day the tables are turned; America has excellent permanent way and rails 50 per cent. heavier than in Great Britain, and English engineers are indebted to America for recent scientific investigations of the highest value to designers. It seems all the more just and desirable therefore to correct false impressions of the past when an opposite state of affairs prevails and when *cæteris paribus* English locomotives were neither less powerful nor less efficient than American.

What was the result of the feeling against the English engines? In pages which are full of interest to the student of locomotive development, Mr. Hungerford shows how, after costly experimenting, the Baltimore and Ohio Company succumbed to the fundamental ideas of English designers, which had crystallised in 1830. The "truck," as he prefers to call it, remained a permanent virtue born out of an early necessity—which perhaps might have been avoided. The development of the locomotive cannot be considered independently of the track. Necessity produced much American ingenuity in flexible wheel base and weight distribution, but it was evidence of inferior permanent way. The truck or bogie did not become necessary in England till many years later.

Among early experiments on the Baltimore and Ohio were those by Ross Winans, with his "friction wheels." We do not follow the statement that "Winans took his remarkable idea to England, and there he was robbed of it."

We find from Wood's "Treatise on Rail Roads" (1838) that experiments made on the Liverpool and Manchester Railway with carriages designed by Winans, Brandreth and George Stephenson respectively, showed that Stephenson's simple outside journal gave the best results. It became, in fact, a universal standard. Regarding the question generally, it is recorded in Marc Seguin's Notes on his visit to England in 1825 that Stephenson had been "studying how to put two axles one above the other with rollers to minimise friction."

The administration of Louis McLane decided in 1837 that the Baltimore and Ohio Company should "cease experimentation in building locomotives," and buy engines of standard types in the open market. This policy has generally been followed by American roads and has been an important stimulus to improvements in design, which largely disappeared in England as the result of an opposite policy which has taken design out of the hands of locomotive builders.

This same McLane had become responsible for the road at a difficult period in its history. It was a critical moment. English finance was inclined to look askance at a country, some of whose States repudiated their debts. Mr. Hungerford admits a grievance which perhaps American public opinion will some day realise and remove, when it has been more fully instructed by such candid and honest historians as he shows himself on every page. There are still representatives of the English bondholders who suffered.

In 1840 McLane visited England to enlist the financial support of the great house of Baring.† At the same time he made a detailed study of English railways, which resulted in a reorganisation of the Baltimore and Ohio lasting for many years. Rails were obtained from England, not for the first time, but now of 51 lb. to the yard. Curves on new construction were to be not less than 1000ft. radius. It is reported that when McLane had become President, he described his charge as "a wreck"—a phrase which is perhaps the true key to the costly locomotive experiments, as it is the measure of the man's later accomplishment in salvage.

Within the century of its existence Hercules has appeared again and again in its individual presidents to restore the fortunes of the Baltimore and Ohio, which fell again, sometimes from circumstances beyond the control of individual men, at others as the direct results of human folly.

Hardly had the road reached its original great objective, the river Ohio, before the "rumblings of approaching conflict" culminated in the stupendous tragedy of the Civil War, told in some of the most interesting chapters of the book. It is a sad tale, not only of the destruction of capital values, but of moral values, redeemed only by the examples of human courage and endurance which war calls forth. "The bridge job alone was an unending one," destruction and reconstruction following hot foot.

God knows where lies the balance of moral values, but, to quote Mr. Hungerford, the Civil War left the railroad "once again to face the hard realities of ordinary life—without the exaltations and the superendeavours, the tremendous splurge and inflation of a vast war machine hard at work. Henceforth there was to be for the whole land the grubbing of humdrum days and weeks and months and years; the hard sharpness of business competition, all the gruelling things that put the temper of men—and railroads—upon metal."

But the road had learnt much, and the record of its services during the Civil War makes us realise, perhaps for the first time, that the American roads had to face such problems half a century before we had to in England. They had their experience behind them—perhaps forgotten by themselves—when America decided that it must pull its weight and its own soldiers in the Great War.

In the second volume the story unfolds ever on an increasing scale, but on the same lines—difficult problems of bridge construction, among the most interesting technically in the book—locomotive controversies, including a remarkable wordy warfare between manufacturer and railway company, a gauge conversion problem in 1871‡, foolish cut-throat competition benefiting no one,§ good report and evil, catastrophe and heroic remedy, Hercules always appearing in the nick of time; finally, the Great War, with State control and its evil legacy of "incalculable damage to *morale*" to be lived down, till—to quote its historian—"the Baltimore and Ohio slips across the threshold of the second century of its existence. What the second hundred years may hold in store for it, no man may safely predict."

To which we would assert that it will certainly have its troubles, but—if we may judge by its past history—will never lack the men to overcome them.

And when we look at some of the charming illustrations, the portrait of Quaker Thomas, the Stephenson engine woven into the inaugural badge as the symbol of steam locomotive power, the early Georgian architecture and design revived in the furniture of the latest dining cars—when we read of the early visits to England for information and financial assistance, may we not share in the pride, even though the pupil may have outstripped the teacher, and early family ties become thin or been sadly frayed by one-sided and tendencious political history in the past?‖

In the sphere of scientific locomotive development towards the end of the nineteenth century, America has taught us valuable lessons, and can justly to-day maintain a claim which it made in the first instance before it was due. But the admitted influence of the G.W.R. "King George V." on the latest design of the Baltimore and Ohio, and the reception which this engine received at the Centenary Exhibition shows that each can still learn from the other.

In conclusion, the reviewer is indebted to the courtesy of the Company which has put these two handsome volumes into his hands, and no one can appreciate better the task which their historian has accomplished so truly in the spirit of Cardano.

The book, in two volumes, is worthily bound and printed, and contains among numerous illustrations specially interesting reproductions of early prints and documents. Inside the covers, and most conveniently for reference, are artistic route maps showing development of the Baltimore and Ohio system at different periods.

Two minor errors we have noticed. The "Stourbridge Lion"—Vol. I., page 4—was built by Foster and Rastrick, not by George Stephenson. The "North Star"—Vol. II., page 345—was designed by Robert Stephenson, not by Daniel Gooch.

There is a discrepancy in Latrobes' story of Von Gerstner—Vol. I., page 98. He can hardly have made the remark quoted of him in 1829–30, as to having escaped from "George Stephenson's thumb!" In 1836 he was in England where he ordered the whole of the material and locomotives required for the first Russian railway, opened in 1837. It was probably after this date that he went to America, and may have made the remark. Von Gerstner—who was a Czech by birth—died at Philadelphia in 1840.

J. G. H. W.

BOOKS RECEIVED.

Airplane Structures. By A. S. Niles and J. S. Newell. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 25s. net.

Stores Accounts and Stores Control. By J. H. Burton. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 5s. net.

Blueprint Reading: A Problem Text. By W. W. Sturtevant. London: The McGraw-Hill Publishing Company, Ltd., 6 and 8, Bouverie-street, E.C. 4. Price 9s. 6d. net.

A Review of the Trade of British Malaya in 1928. By L. B. Beale, C.B.E. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 3s. net.

The Depth of Sewage Filters and the Degree of Purification. Illinois State Water Survey Bulletin No. 26. By A. M. Buswell, S. I. Strickhouser, and others. Illinois: State Water Survey, Urbana, Ill., U.S.A. Price 50 cents net.

† The name appears often in the books of Robert Stephenson and Co., as agents for locomotives sent to America between 1832–37. In later years it had its own financial crisis to meet.

‡ It is little known in England that there was a great variety of gauges in the United States of America so late as 1873. Out of a total of about 43,000 miles, no less than 21,500 were of gauges from 4ft. 9in. to 6ft. Complete unification to 4ft. 8½in. did not take place till after 1897 (letter to J. G. H. Warren from J. T. T. Wallis, Pennsylvania Railroad, February 10th, 1928).

§ The policy of the "strike roads" was a wilful destruction by capitalists of capital values, far exceeding the follies of the Railway Mania of the 'forties. A good summary will be found in the *Cambridge Modern History*, Vol. VII., Chap. XXII.

‖ Recent American historians have been at pains to correct false traditions, notably the late Herbert L. Osgood, of Columbia University.

The Royal Agricultural Show at Harrogate.

No. I.

THE eighty-eighth annual Show of the Royal Agricultural Society of England will be held at Harrogate from July 9th to 13th, under the presidency of Viscount Lascelles, and, provided that the weather is favourable, the event should prove very successful. Yorkshire is a famous county for agriculture, and Harrogate is an admirable centre, being easy of access from all directions.

The entries in the implement section are fairly satisfactory in point of numbers. The number of stands is 431, compared with 467 at Nottingham last year, and the length of shedding in this section is 10,851ft., or 1100ft. less than at Nottingham. In the livestock, poultry and produce sections the entries show a slight improvement. There are 3403 entries of horses, cattle, goats, sheep and pigs, and 943 head of poultry.

The number of new implements for agricultural or estate purposes entered for the Society's silver medals is smaller—much smaller—than usual. This year only twelve firms are competing. Messrs. A. C. Bamlett, Thirsk, have entered a two-horse mower with a double drive; the Auto-mower Engineering Company, Ltd., Norton St. Philip, near Bath, a mole drainer and pipe layer; Bamfords, Ltd., Uttoxeter, a vertical petrol engine; Barford and Perkins, Ltd., Peterborough, a bottle washing machine; Teasdale Bros., Ltd., Darlington, an artificial manure drill; John Wilder, Reading, a new cultivator; Simas Rototillers, Compton-street, London, a rapid motor mower; Hosier Open Air Pure Milker, Ltd., Mexcombe, Marlborough, a combined milking, brine cooling and bottling plant; and Gascoignes (Reading), Ltd., a milking machine.

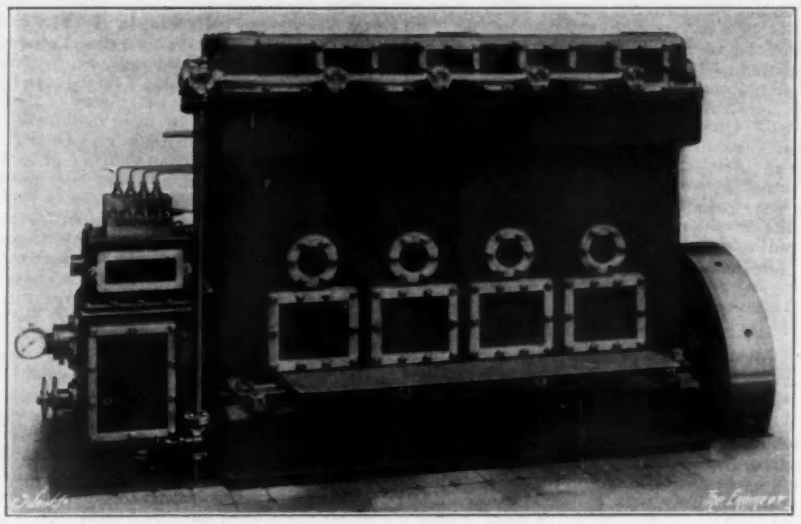


FIG. 1—110 B.H.P. COMPRESSORLESS COLD-STARTING HEAVY-OIL ENGINE—CROSSLEY

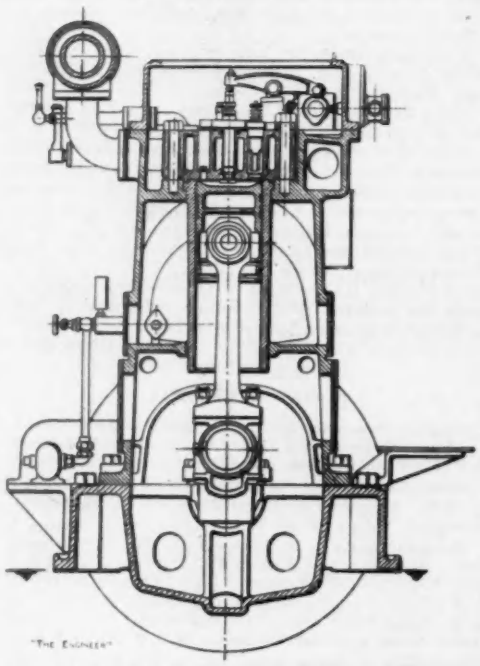


FIG. 2—CROSS SECTION THROUGH CROSSLEY ENGINE

CROSSLEY BROTHERS.

Visitors to the Show will find two really new engines shown on Crossley Brothers' stand in addition to this firm's usual range. Fig. 1 illustrates a new vertical oil engine, described by the makers as a compressorless Diesel engine of 110 B.H.P. normal rating, and Fig. 2 represents a transverse section. The speed is 450 revolutions per minute. All the working parts are totally enclosed and lubricated by oil under a pressure system. The design is robust and of a pleasing appearance. The fuel oil pumps are grouped together in one unit at one end of the engine, which makes an accessible and compact arrangement. The overhead valve gear is entirely encased, the inlet and exhaust valves being operated directly from valve levers without the introduction of push rods. The cam shaft, also overhead and enclosed, is driven by a silent roller chain with adjustment gear which in no way disturbs the valve timings. Starting up is by compressed air applied to all four cylinders, so as to give rapid acceleration, and the engine may be put in motion from "dead cold" within a few seconds. This engine is typical of a range of Crossley vertical oil engines having from two to four cylinders for all classes of duty.

Fig. 3 represents the new Crossley two-cylinder enclosed horizontal heavy oil engine of 44 B.H.P. normal rating at 375 revolutions per minute. In this engine all the moving parts are fully protected from dust and dirt, and the engine is provided with a complete system of automatic lubrication. With this design the side shaft and gear wheels are entirely abolished, the cam shaft being arranged across the top of the cylinders, enclosed, and driven by a silent chain which works in an oil bath. Push rods make direct connection between the cams and the valve levers for the opening and closing of the inlet and exhaust valves. These valves are in detachable cages and are readily removable for grinding-in purposes. Starting up is by means of compressed air stored in a receiver which is self-charged, when necessary, from the engine cylinders. The engine, we understand, operates upon the cheapest grades of fuel oil and the consumption at full and three-quarter load is given as being 0·43 lb. per B.H.P. per hour.

Another example is that of the Crossley vertical enclosed two-stroke oil engine shown direct coupled to a G.E.C. dynamo, 9 kW, 230 volts, so as to form a complete generating set. This two-stroke oil engine, which also, so we are informed, operates on the cheapest grades of fuel oil, differs in construction from the ordinary two-stroke oil engine in having a separate scavenge pump so as to ensure perfect scavenging of the cylinder from the products of combustion and clean working. Pump lubrication is applied to the main bearings and other moving parts so as to provide immunity from hot bearings and to reduce wear and tear.

A paraffin engine, 7½ B.H.P., is representative of a range of standard open type engines, built in sizes from 4 B.H.P. to 17 B.H.P. These engines have magneto ignition with petrol attachment for instant starting. There will also be shown a number of small engines of the enclosed type of 2, 3, and 6 B.H.P., working on paraffin, but started on petrol.

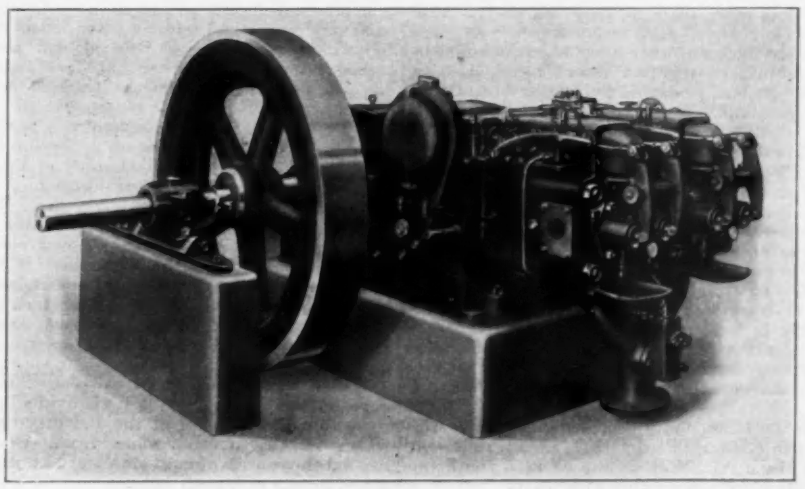


FIG. 3—44 B.H.P. ENCLOSED-TYPE HEAVY-OIL ENGINE—CROSSLEY

MILKING MACHINERY.

Milking by the aid of machinery has not made such headway in this country as it appeared likely to do at one period. During the war, when agricultural labour was scarce, dairy farmers turned to milking machines to solve their labour troubles, but, with the return of men to the land at the cessation of hostilities, the use of the mechanical milker fell into abeyance again. The chief reasons for the return to manual milking were to some extent deficient appliances and want of knowledge on the part of the users. During the last few years milking machinery has undergone much improvement, and, for large milk-producing herds, mechanical methods are on the increase. There are still, however, many farmers who believe that milking machines are injurious to the cattle. With modern appliances this need not be so, if the machine is not relied upon to draw the uttermost drop of milk from the udder. That should always be effected by hand, but even so the amount of hand labour required is infinitely less than formerly. With the latest appliances one unit is capable of milking about seven cows per hour, and, on that basis, two men are required to every four units, one man looking after the units and the other doing the "stripping." When machines are properly attended to there is no comparison between mechanical and manual milking on the score of cleanliness. It is customary in modern methods to adopt steam sterilisation and cooling, so that the plants require a fair amount of intelligence on the part of the attendants.

ALFA LAVAL COMPANY.

The Alfa Laval Company, Ltd., Grosvenor-road, London, S.W. 1, has specialised in milking plant for many years and claims to have over 700 milking machines in operation in this country. At Harrogate this company will exhibit a portable milking shed for six cows, specially designed for farmers who keep their cattle out all the year round on high and dry ground. With this shed the milk is drawn right into the churn. In a separate portable engine-house is a small petrol engine which drives a refrigerating plant for cooling the milk, an electric light set and a pump for operating the milking plant. Finally there is a boiler for generating steam up to 50 lb. pressure, which is used for sterilising the dairy utensils and the milk pipe lines.

In the latest milking system made by the Alfa Laval Company the pulsations necessary to draw the milk from the cow are not created by any small self-contained vacuum pump situated on each pail, as was customary twenty years ago, but by a simple mechanically-operated valve in the pump. This valve is always working at uniform speed and cannot be tampered with; the pulsations are therefore regular and uniform. The pump employed, which is of the

rotary variety, produces a continuous vacuum, thus obviating the employment of a reservoir. A special pulsation pipe line runs alongside the vacuum pipe throughout the plant and transmits the pulsations from the pump to each machine. The pulsations are

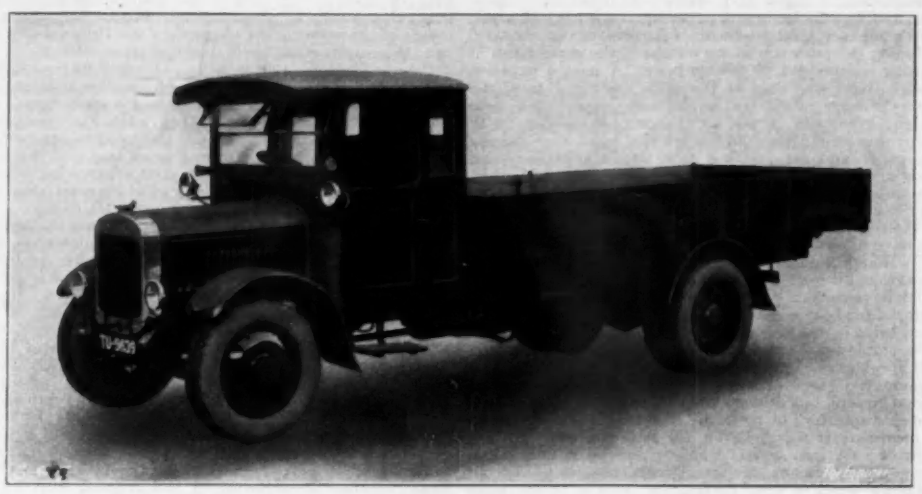


FIG. 4—5/6-TON HINGE-SIDE PETROL LORRY—THORNYCROFT

therefore maintained regular and uniform and cannot be altered. Although the pump valve can produce far stronger pulsations than any pulsator, they have a considerable distance to travel from the pump to the teat cups. This difficulty is overcome by means of an ingenious device, a simple piston situated immediately below the teat cups, which acts as a pulsation reinforcer and restores the pulsations to their original strength. In this way the pulsations in the teat cups are kept as vigorous as they are on leaving the pump, and, because the piston is actuated by the pump, they must always retain the same speed and frequency.

THORNYCROFTS.

For the faster transport of heavy loads up to 5 and 6 tons the petrol wagon with hinged sides, which will be shown by John I. Thornycroft and Co., Ltd., Smith-square, Westminster—Fig. 4—is specially adapted. The engine has four monobloc cylinders and is rated at 50–60 horse-power. The cylinder dimensions are 4¼in. bore and 6in. stroke. The cylinders have two detachable heads, which render the inspection of the valves easy. All the valves are on one side and are operated by one cam shaft. The cylinder block is secured to the crank case which supports the crank shaft and cam shaft, the crank shaft being carried in three long white metal bearings, the caps of which are bolted to the top half of the crank case. The bottom half of the latter is readily detachable. An enclosed governor is fitted on the engine to prevent "racing." Ignition is by means of high-tension magneto with automatic advance, the drive being by means of a shaft and gear wheels from the forward end of the crank shaft. An immersed oil pump in the base chamber and driven by skew gearing from the cam shaft provides copious lubrication, a gauge filter being fitted on the suction side. When the base chamber is removed, the pump, drive and filter can be detached in one unit by the unscrewing of one nut. From the pump the oil is forced under pressure to a tube radiator, the latter being mounted on cup-shaped rubber buffers. It is built up with detachable top and bottom water vessels, enabling new tubes to be easily fitted. The pump and fan are driven by a belt from a pulley on the magneto driving shaft, and the belt tension can be adjusted by a device on this pulley. The transmission is by means of a single-plate clutch and a four-speed gear-box. At the rear of the gear-box is a fabric universal coupling that

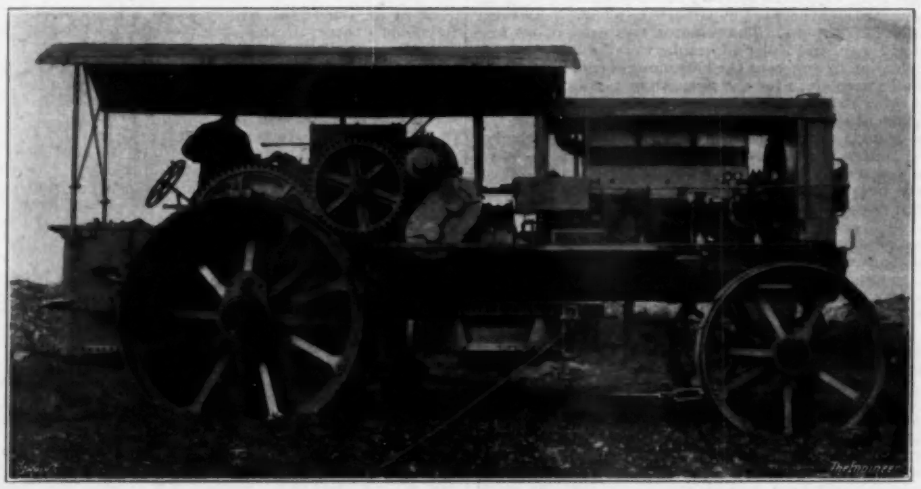


FIG. 5—150 H.P. HEAVY-OIL PLOUGHING ENGINE—FOWLER

tunnel cast in the side of the crank chamber, whence it passes through ducts to the cam shaft bearings and main bearings. The big-end bearings are also lubricated under pressure through the drilled crank shaft. Cooling is by means of a pump and fan with a gilled transmits the power to an intermediate propeller shaft which is supported near the rear end by a fully protected ball bearing flexibly attached to one of the frame cross members. A tube connects this intermediate shaft to the rear axle worm shaft by means of enclosed metallic couplings, the one at the forward end being free to slide. The rear axle is a cast steel casing with full floating differential shafts driven by an overhead worm with a reduction ratio of 8·25 to 1. The casing containing the worm and differential gears can be easily removed without the load being removed.

The chassis frame is of pressed steel, channel section, and the power unit is suspended on the three point system, the supporting brackets having rubber blocks to absorb the stresses in the crank case due to distortion of the frame. The wheel base is 14ft. 6in. and the ground clearance 10in. fully loaded.

JOHN FOWLER AND CO.

The exhibits of John Fowler and Co. (Leeds), Ltd., will cover an unusually wide range, and two of the machines to be shown have not hitherto been seen at "The Royal." One of them, Fig. 5, is a 150 horse-power high-speed Diesel engined cable ploughing plant, the engine of which was built by the M.A.N. Company and will run on Diesel oil, Solar oil and any similar fuel with a specific gravity not exceeding 0·90. One of the advantages of this type of motor for agricultural purposes is that no magneto or carburetter is required. The injection nozzles are of a simple type and can be removed and replaced easily. The engine is started from cold by an electric starter without the aid of compressed air or preliminary heating, and a special device enables the driver to cut out some of the cylinders so that he can run on either one, three or six cylinders according to the load, and so reduce the fuel consumption. These engines are built on the same lines as the Fowler steam cable engine, the main frame being constructed in the form of a locomotive boiler with horn plates at the rear to carry the driving shafts and a semi-tubular barrel in the front to carry the engine, horizontal rope drum and coiling gear. The totally enclosed transmission gear runs in oil. It will be observed that the engine has very large travelling wheels for operating on soft ground.

The other new exhibit is an 8-ton three-wheeled

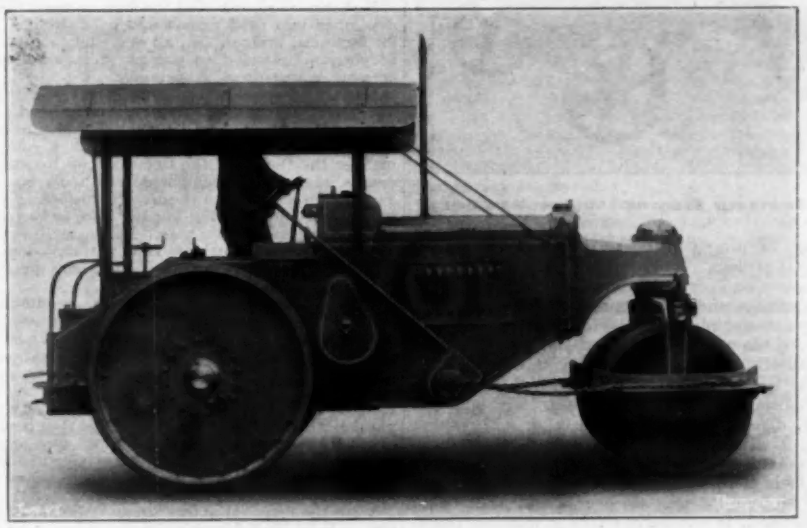


FIG. 6—HEAVY-OIL-ENGINED ROAD ROLLER—FOWLER

road roller, Fig. 6, also operated by a Diesel engine. This roller is built on the same lines as the petrol-engined rollers made by this firm, with which our readers are familiar.

In addition to the above-mentioned exhibits Messrs. Fowler will also be represented by a 6/7-ton steam wagon of the three-way tipping type with a stayless vertical boiler and compound V engine. This wagon has a three-speed gear-box and the final transmission is by worm and wheel.

A road spraying and re-surfacing plant by this firm is built on a compound steam road roller and is arranged for spraying tar and bitumen mixtures at high pressure on to the road surface and covering them with grit or chippings immediately afterwards by means of a gritting machine which is hauled immediately behind the roller. The tank in which the binding material is carried is situated under the boiler barrel so that the heat of the boiler assists in keeping up the required temperature. A rotary pump forces the material through pipes to the row of spraying jets at the back of the roller, which cover a working width of 7ft. 6in. Any number of jets may be turned off to reduce this width when required. A steel gritting machine is fitted with patented distributing gear for spreading the stone evenly over the surface. The chief uses of the plant are:—(1) For spraying and gritting roads to preserve the existing surface; (2) for re-surfacing roads with new road metal on the penetration system; (3) when not required for these uses, the roller can be used for ordinary rolling work, scarifying, &c. Another feature of Messrs. Fowler's stand will be the concrete plant, elevators and block-making machinery.

RANSOMES, SIMS AND JEFFERIES.

The well-known Ipswich firm of Ransomes, Sims and Jefferies will have a very wide range of exhibits, including steam traction engines, thrashing machines,

ploughs, and other purely agricultural implements. A special feature of their stand will be the display of electric motors for agricultural purposes. Experience has demonstrated that, for farm work, the ordinary kind of protection for electric motors is not sufficient. The firm will exhibit a drip-proof type direct-current motor, 5 B.H.P. at 1250 r.p.m. This motor is intended for driving line shafting or such machines as mills, in which a comparatively high-speed motor can be used with advantage. On the alternating-current side it will exhibit a slip-ring type of induction motor giving 6 B.H.P. at 1400 r.p.m. which is also of the drip-proof pattern. A small alternating-current motor of 1½ B.H.P., 1400 r.p.m., of the drip-proof type, will also be shown. It is suitable for driving such machines as chaff cutters, for which the power required is small, and when the drive would possibly be taken from line shafting, having one or two machines of small power available for the drive.

A very large number of agricultural machines require to be driven at slow speeds, and Ransomes will therefore exhibit two alternating-current motors in which gear reduction is employed. One of them is a 2 B.H.P. squirrel-cage induction motor, mounted on a pedestal and provided with reducing gear giving a speed on the secondary shaft of 280 r.p.m. This motor would be suitable for direct driving by belt most of the various forms of barn machinery obtaining on a farm. Another motor with reducing gear is a portable agricultural motor, which has three driving

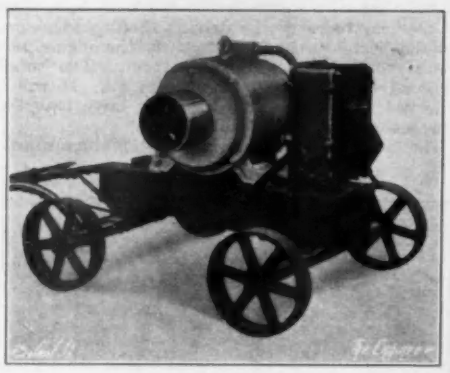


FIG. 7—PORTABLE ELECTRIC MOTOR—RANSOMES

shafts, each running at different speeds and provided with special pulleys. This motor, together with its starting gear and cable drum, is mounted on a portable carriage and can therefore be wheeled from place to place and plugged into the nearest source of supply. As the makers point out, such a portable motor naturally renders unnecessary the installation of several small motors for individual machines. Messrs. Ransomes will also show a totally enclosed 10 B.H.P. direct-current motor driving a thrashing machine. This motor is mounted on portable four-wheeled undercarriage, complete with starter and switch. It is designed to suit special conditions of starting required for this class of work, and, being totally enclosed, is naturally entirely weather proof.

Our illustration Fig. 7 represents a portable motor and switchboard mounted on a four-wheel carriage for transport. It is fitted either with shafts or with a draw-bar and is serviceable for driving thrashing machines, food preparing machinery or pumps. When required to use a slow-running belt from the motor to the machine a combined reduction gear and belt pulley can be provided.

(To be continued.)

The Contribution of Manchester Researches to Mechanical Science.*

By R. W. BAILEY, Associate Member.

(Concluded from page 716.)

Eaton Hodgkinson (1789–1861).—The name of Eaton Hodgkinson will be known to many engineers through his responsibility for the well-known Hodgkinson formula for the strength of cast iron columns. Had cast iron retained its early position as the principal constructional metal his name would now be known much more widely, for his researches and work upon the strength and elastic properties of this material were classical and stand to-day. This work, however, was only a part of his contribution to mechanical science, and in his day he was probably the leading authority in this country on the theory and strength of structures. At one time a pupil of Dalton, he afterwards devoted attention to the theory of elasticity and strength of materials. In association and with the help of Fairbairn he conducted in Manchester much original research. His first published paper was produced when he was thirty years of age, and in 1847, at the age of fifty-eight years, he left Manchester to take up the appointment of Professor of Mechanical Engineering at University College, London.

Hodgkinson's first paper gave an analytical treatment of the transverse strength of beams and was of a general character, covering the case when the elastic behaviour in compression and tension is different. Tests were made upon timber beams of several woods; the position of the neutral axis was determined experimentally, and the data obtained were utilised to show how the resistance of beams of different constructional forms and dimensions could be calculated. Altogether the paper gave a very creditable and reliable treatment of the subject.

Suspension bridges next claimed Hodgkinson's attention, and in 1828 he read a paper upon the subject which gave a full analytical treatment of the form of the catenary, including the influence of the weight of the chain when of varying section and of the roadway. A second paper of Hodgkinson's was read at the same meeting. In it the results of some calculations he had made respecting a chain bridge over the Irwell connecting Pendleton with Broughton were given. In the interval between preparing the paper and its printing this bridge collapsed, and Hodgkinson added an appendix dealing with its failure. The failure was caused by a troop of soldiers marching over it in step, thereby setting up vibration, and it must be the traditional case of which we have all heard but so few have known the origin.

To Hodgkinson is due the credit of having established the rational design of cast iron beams, in connection with which he remarks: "The earliest use of this most valuable material for beams has been but of recent date: so far as I can learn it was first used by Boulton and Watt, who in 1800 employed beams . . . in building the cotton mill for Messrs. Phillips and Lee in Salford." It soon became the chief constructional metal for beams and bridge girders, but erroneous views are held regarding the proper disposition of metal in structural parts subjected to bending. It was believed, for example, that the best form of cast iron beams was secured by having equal flanges. By means of theoretical treatment and an elaborate series of tests Hodgkinson arrived at the most economical proportions of cast iron beam cross sections, and he devised a rational formula for their strength. The results of this research were given in a paper read in 1830. Its magnitude as an investigation may be gathered from the fact that, in all, thirty-five beams were tested, ranging in span from 4ft. 6in. to 9ft. and in weight from 36 lb. to 244 lb. Fairbairn's testing lever was employed for loading purposes, and all the test beams were supplied, and the cost of the investigation was borne, by Fairbairn's firm. This research had considerable practical value.

Hodgkinson records that the form of beam cross section developed was used extensively by Fairbairn and Lillie for factories, bridges, &c., all over the country, and that Stephenson intended to employ it in a railway bridge crossing Water-street, Manchester.

Shortly afterwards Hodgkinson investigated the behaviour of beams under impact, and he read two papers before the British Association giving the results of his researches. In these he developed in a comprehensive manner the theory of the forces set up by impact. The results of his tests compared well with his calculated values. In addition to the tests upon beams a few tests were carried out on the impact of a body falling upon another suspended by a wire. The research is of interest, as it gives a fairly complete view of the theoretical aspect of the subject and shows that Hodgkinson was fully aware of its practical significance.

In 1837 Hodgkinson presented the results of his tests upon the transverse strength and other properties of hot and cold-blast iron in a paper read before the British Association. In carrying out this research attention was paid to the permanent set occurring at even very small loads, and later the matter was investigated more closely. Hodgkinson found that the defect of elasticity followed a parabolic law from which he concluded that permanent set of small but finite magnitude occurred even at very small loads. A paper upon the subject applying the law to other materials, such as stone, timber, &c., was read before the British Association in 1843.

With the financial assistance and interest of Fairbairn, the scale of Hodgkinson's investigations grew in magnitude, and in 1840 he presented the results of his research upon cast iron pillars. As in the research upon beams, Fairbairn provided the testing facilities and bore the cost of the inquiry, which involved the making of 277 tests upon pillars ranging in length up to 7½ft.

Euler's formulæ for the stability of struts had been developed some years earlier, but until Hodgkinson made his investigation no large-scale research had been carried out to test their validity, particularly with such a material as cast iron, where the relation between stress and strain is not linear and there is a departure from perfect elasticity even at low stresses. The research was carried out in a masterly way, and Euler's formulæ were found to require modification to represent the behaviour of cast iron pillars. Formulæ were given for the strength of cast iron pillars of solid cylindrical form having rounded and flat ends. The influence of enlarging the cross section at the middle was investigated, as was also the behaviour of hollow cylindrical pillars and pillars of rectangular and of H and I cross section. A few pillars in wrought iron and different woods were tested in order that a comparison of the several materials examined could be made. A number of important and interesting tests were made upon pillars loaded for a period of fifteen months during which a number of readings were taken of deflection. The temperature was not constant, varying from 39 deg. Fah. to 74 deg. Fah., and its magnitude was recorded. Four similar columns were loaded by different weights in the proportion of 1, 1·75, 2·5, and 3·25. The first two showed no measured progressive increase in deflection after the initial deflection; the deflection of the third increased steadily throughout the period of test, and the fourth behaved similarly until failure occurred five months after the beginning of the test. These tests probably constitute one of the first, perhaps the first, systematic group of long-duration tests, now commonly known as creep tests.

This research of Hodgkinson ranks as one of the most complete upon pillars, and his results for cast iron are of value to-day.

The author has not had an opportunity of consulting the report of the Commissioners appointed to inquire into the strength of iron bridges to which Hodgkinson contributed the results of some of his researches bearing upon the Conway and Britannia bridges. It has already been mentioned that the greatest problem presented was the crumpling of plates at the compression side of the tube, and this was a matter to which Hodgkinson gave special attention. Tribute to the successful character of his work is, however, paid by Stephenson, who, in writing to Fairbairn in 1848, said: "His experiments alone have given the true law that governs the strength of different sized tubes. Both your plan and my own for calculating the strength are empirical, but Hodgkinson's experiments, and his deductions from them, give the true law with remarkable consistency." It may be taken from this declaration that Hodgkinson's researches provided the necessary means of interpreting the strength of the Britannia bridge from the results obtained in model experiments.

Osborne Reynolds (1842–1912).—Osborne Reynolds, like Dalton and Joule, possessed the philosophic mind and a gift for demonstrating or investigating a phenomenon by simple and ingenious experiment. He also possessed unusual mathematical power, and ability in its application to natural phenomena. Trained as an engineer, much of his work had immediate bearing upon engineering science and development, but the full import of his researches and teaching is only now adequately appreciated.

Whereas Hodgkinson and Fairbairn applied themselves chiefly to the theory and behaviour of materials and structures, Reynolds does not appear to have given much attention to these matters. To some extent he followed Joule in dealing with the behaviour of gases, heat transmission, and the condensation of steam, and one of his most extensive experimental researches was appropriately a redetermination of the mechanical equivalent of heat. He gave attention chiefly, however, to research in dynamics. His original work upon hydro-dynamical problems occurring in engineering practice, such as lubrication, fluid friction, the action of waves and currents in determining the beds and foreshores of estuaries and in connection with turbines and pumps, constitutes an unrivalled contribution to current engineering theory and development. Joule's anticipation of the growing importance of deductive methods was exemplified by Reynolds, who remarks in one of his papers: "These results and conclusions were in the first instance arrived at during a long-continued investigation, undertaken with a view to bringing the general theory of hydro-dynamics into accord with experience, rather than with any special reference to the subject in hand, but have since been to some extent made the subject of special investigation." The unusual combination of engineer and mathematical physicist accounts for the basic character of much of Reynolds's work.

Before considering the contribution made by Reynolds's researches it is of interest, because it illuminates their character, to notice his inclination and training, particulars of which are taken from the Royal Society memoir written by Professor H. Lamb.

In his letter of application for the professorship at Owens College, Reynolds wrote: "From my earliest recollection I have had an irresistible liking for mechanics; and the studies to which I have specially devoted my time have been mechanics, and the physical laws on which mechanics as a science are based. In my boyhood I had the advantage of the constant guidance of my father, also a lover of mechanics and a man of no mean attainment in mathematics and their application to physics." Reynolds's father, the Rev. Osborne Reynolds, who was thirteenth Wrangler in 1837, was chiefly responsible for his son's early education. At nineteen years of age Reynolds entered a small mechanical engineering workshop at Stony Stratford, where he spent one year before going to Queen's College, Cambridge, to work for Honours. In 1867, at the age of twenty-five, he graduated seventh Wrangler, and after spending about one year in the office of a civil engineer he was elected to the newly-instituted professorship of engineering at the Owens College.

With the exception of his first paper dealing with the suspension of a ball by a jet of water, Reynolds did not publish papers upon mechanical science until five years after his appointment, his attention in the meantime being confined to subjects of an electrical or magnetic character upon which he read several papers. From that year until 1896 his researches in mechnical science were represented by a succession of papers, many of a fundamental character, and these will now be dealt with in the categories in which they fall.

Reynolds's most important contribution was made in connection with fluid motion. His treatment of the theory of film lubrication is now classical and forms the foundation of subsequent theory relating to all film-lubricated bearings, both of cylindrical, and plane form, as employed by Michell and Kingsbury for thrust bearings. The development of thrust bearings of this type was dependent in an important degree upon the publication of Reynolds's theory. As a mark of his indebtedness Mr. Kingsbury, in 1919, founded a research fellowship to be called the "Osborne Reynolds Fellowship in Engineering" at the Manchester University as some recognition "of the debt which he owed to Reynolds's researches in lubrication in connection with the development of the Kingsbury thrust bearing." Unfortunately such instances of the recognition by engineers and the industry of the debt owed to scientific research are in this country all too rare. The value of this one contribution of Reynolds's, directly or indirectly, is immense. It has provided the theoretical basis for analysing the problem of lubrication of steam-turbine and all other high-speed bearings, it has led to the displacement of thrust bearings of the collar type employed for ship propeller shafts, and it has resulted in bearings capable of carrying loads at speeds that otherwise would have been impossible. In the same category and perhaps of equal importance is his work upon the flow of fluids in pipes and channels, important not so much from the quantitative results obtained, although these are valuable, but for the general basis he has provided for dealing with fluid motion. That the flow of a fluid could be of two different kinds, namely, what are now known as stream-line and turbulent, was already known; Reynolds, however, not only demonstrated the two conditions in the case of pipe flow and found the corresponding law of resistance, in the case of turbulent flow proposing a new logarithmic formula, but he determined generally the critical speed at which change from one to the other may occur. More important still, he discovered the basis for the similar flow of all fluids by finding "that the general character of the motion of fluids in contact with solid surface depends on the relation between a physical constant of the fluid, and the product of the linear dimensions of the space occupied by the fluid, and the velocity." This quantity, which has no dimensions and is now known as the Reynolds number, he found

* The Institution of Mechanical Engineers. Manchester meeting, June 25th, 1929.

to be $\frac{D\,v}{\mu'}$, where D is the diameter of the pipe or the characteristic linear dimension of the conduit or body considered, v is the speed of flow, and μ' is the kinematic viscosity of the fluid. Whilst Reynolds's logarithmic formula for flow in pipes has not been much used practically for water, as it is less convenient for calculation purposes than the well-known Weisbach empirical formula, his general relation has proved of great value in other cases such as oil and chemical fluids. The principle discovered, moreover, is of fundamental importance in connection with model experiments since it determines the condition of similarity of motion. It may be mentioned here as an example of the practical importance of the principle discovered that the development of the modern large low-head hydraulic turbine is entirely dependent on the results of model investigations based upon the laws of dynamical similarity. Subsequent to his research upon the flow of fluids in pipes Reynolds presented an extensive paper of a theoretical character in which he demonstrated the existence of the critical condition associated with the change in the character of flow.

Having established the condition of similarity of flow of fluids in conduits Reynolds shortly afterwards investigated the phenomena of bed formation in rivers and estuaries, and he determined the conditions under which the bed formation can be reproduced or predicted by means of models. His first paper on the subject was read in 1887 before the British Association. This highly important research, as has already been noticed, arose, like his investigation into the flow of fluids in conduits, from his philosophic interest in hydrodynamics.

In the paper referred to Reynolds discussed the general conditions determining the deposition and removal of granular material by flowing water, and described the results of experiments upon a model of the Mersey estuary in which he reproduced the general characteristics of bed formation and state of tide found in the estuary. His experiments were of a preliminary character, however, and they raised a number of points upon which further investigation was necessary; but so impressed was he by the power of the method that he remarked: "I have called attention to these results because this method of experimenting seems to afford a ready means of investigating and determining beforehand the effects of any proposed estuary or harbour works; a means which, after what I have seen, I should feel it madness to neglect before entering upon any costly undertaking."

Arising out of this contribution, the British Association appointed a committee to investigate the action of waves and currents on the beds and foreshores of estuaries by means of working models, and Reynolds planned and carried out the research at Owens College. The investigation involved numerous experiments upon parallel foreshore sections, V-shaped estuaries with and without flowing land water and a long river, the effect of unsymmetrical estuaries, and the influence of groynes and walls. The research, which was fully recorded by three reports made by the Committee, established conditions under which models can be used to predict bed formation, and thus an extremely valuable method was placed at the disposal of engineers to guide and determine design. There are many problems in which the method is of importance to mechanical engineers. For example, it has been used with success in recent investigations in the Engineering Department of the Manchester University to determine the effect of the inflow and outflow from the condensing water conduits of a super-power station situated on the banks of an estuary, upon the siltation in their vicinity, and on the magnitude of the currents set up in the neighbourhood of their inlets and outlets.

Reynolds devoted attention to vortex motion and devised some very beautiful experiments to demonstrate vortices in fluids. Whilst this in itself as a contribution to mechanical science does not rank in importance with the cases we have so far considered, it is possible that it has some connection with his invention of the turbine pump wherein vanes are substituted for Thomson's vortex or whirlpool chamber. If so it can be said that Reynolds's philosophic interest in fluid motion and keen practical insight was in this case responsible for the present forms of multi-stage high-lift centrifugal pumps, and turbo-blowers. His patent specification No. 724 of 1875 shows that in addition to covering pumps and compressors, he included in a comprehensive manner multi-stage turbines driven by liquids, vapours, and gases. The extent to which he anticipated turbine development is shown by the following extract from his specification: "In the case of obtaining motive power hereinbefore described the novelty of my invention consists in repeating the action and again causing the fluid to traverse one or more additional sets of moving passages alternating with fixed passages. In both cases, that is, in obtaining motive power and raising and forcing fluids, instead of alternate sets of fixed and moving passages, all the passages may be in motion, but in that case the alternate sets of passages must move in opposite directions. It is not necessary that the several sets of moving passages should be connected with or move round the same axis or shaft." Thus Reynolds anticipated the multi-stage turbine, opposite rotation of the two elements as in the Ljungström turbine, and multi-cylinder machines.

This was not his only contribution to turbine development. In 1885 he worked out the theory of the convergent-divergent conduit or nozzle used later by De Laval, and he discovered that the velocity at the throat corresponded with that of sound.

Reynolds made notable contributions to the theory and knowledge of heat transmission between a gas and a conducting surface over which it flows. In 1874 he read his modest but fundamental paper "On the Extent and Action of the Heating Surface of Steam Boilers," wherein he gave his now well-known law: $H = A + B\,\rho\,v\,t$, the value of which has only been adequately appreciated during the last twenty years. To-day it forms the basis of all rational treatment and design of heating and cooling surface in contact with liquids and gases in motion. Eighteen months earlier he read a paper "On the Condensation of a Mixture of Air and Steam upon Cold Surfaces." His conclusions so far as they relate to surface condensers were:—

1. That a small quantity of air in steam does very much retard its condensation upon a cold surface; that, in fact, there is no limit to the rate at which pure steam will condense but the power of the surface to carry off the heat.

2. That the rate of condensation diminishes rapidly and nearly uniformly as the pressure of air increases from 2 to 10 per cent. of that of the steam and then less and less rapidly until 30 per cent. is reached, after which the rate of condensation remains nearly constant.

3. That in consequence of this effect of air the necessary size of a surface condenser for a steam engine increases very rapidly with the quantity of air allowed to be present within it.

Joule made his experiments upon condensation of steam carefully freed from air, and when his conclusions are taken with those of Reynolds it will be seen that over fifty years ago the factors effecting efficient condensation were ascertained by them. The advent of the steam turbine and its need of high vacua have led only comparatively recently to full advantage being taken of the principles disclosed by these investigators. These investigations and the laws of gases and vapours due to Dalton and Henry make Manchester's contribution to the discovery of the fundamental principles of condenser engineering unique.

Reynolds devoted much attention to the molecular action associated with heat transmission, and gave a number of important papers of scientific interest dealing with the subject. Although these papers were not in themselves of direct importance in mechanical science, it can hardly be doubted that, as in the case of fluid motion, without such wide scientific inquiry the important generalisation we have noticed would not have been made.

It appears from the opening paragraph of one of his papers that Reynolds became interested in the action of the screw propeller at about the time he went to Cambridge, and over the intervening period he investigated the subject as opportunity occurred. It is not surprising, therefore, that a number of his papers are devoted to screw propellers and their action in influencing the steering of ships. These papers are of importance in illustrating the value of models in such investigations. His first papers which dealt with the racing of screw propellers, gave the results of his model experiments which led him to discover the important action of air entrained in the water by the blades of the propeller in causing racing. These papers were followed by two communications to the British Association, which resulted in the appointment of a Committee "to investigate the effect of propellers on the steering of vessels," and this Committee was responsible for carrying out a number of tests upon vessels of various sizes and types, the results of which confirmed the deductions made by Reynolds from his model experiments. The reports of this Committee were published by the British Association. It may be of interest to mention that in his 1876 paper Reynolds suggested that models in the form of small steam launches correctly proportional in dimensions, displacement, dynamical characteristics, and power should be employed in training naval officers in the manœuvring of ships, especially for the purpose of ramming. He remarked: "When two ships are manœuvring so as to avoid or bring about a collision each commander has to take into account the movements of his opponent. To enable him to do this with readiness, it would be necessary to have friendly encounters. A fight between two ships whose captains had never fought would be like a tournament between two novice knights who had never practised with pointless spears." Reynolds returned ten years later to the subject of the use of boat models employed under conditions of dynamical similarity by suggesting their use for investigating the qualities of lifeboats. By way of example he remarks: "The behaviour of a model 3ft. long in waves 2ft. high and with a wind 20 miles per hour would correspond with that of a boat 27ft. long in waves 18ft. high, and a velocity of the wind 60 miles an hour." The author is not aware that this suggestion was taken up; its citation, however, together with other examples which have been given, will serve to show the extent to which Reynolds had developed the idea of using models.

In connection with the testing of steam engines Reynolds gave an important paper upon the theory of the steam engine indicator, and he was responsible for the design and installation at Owens College of probably the most complete group of three experimental engines, constituting as required a compound or triple-expansion engine, to be found at that time. An important research was carried out upon this equipment, the results of which were presented in a paper, in which he introduced his method of combining indicator diagrams of multi-expansion engines. This method applied to the diagrams of the trials yielded useful information upon cylinder condensation. In connection with the testing apparatus Reynolds's knowledge of vortex action enabled him to make a most important improvement of the Froude brake, which rendered it stable and capable of easy adjustment. The most important contribution to mechanical science associated with this equipment, however, was its use to determine the mechanical equivalent of heat upon a scale altogether outside the resources available to Joule.

This research, planned by Reynolds and carried through by Moorby, employed a Froude brake as its calorimeter in which the water was raised in temperature from approximately freezing point to boiling point at atmospheric pressure. Tests were carried out under conditions of constant speed and temperature, but at two different loads, corresponding to about 35 and 70 B.H.P., so that by taking differences in the work done and the heat produced data were obtained free from major errors arising from radiation and other heat leakage losses. Each test involved an initial period of about one hour during which steady conditions were obtained, and readings were taken over the following hour, the magnitude of the quantities measured in a large power test being of the following order:—Revolutions, 18,000; total work done, 135,000,000 foot-pounds; total weight of water raised 180 deg. Fah., 960 lb.; total apparent heat generated, 170,000 B.Th.U.

Altogether eighty tests were made, of which rather more than half were believed to involve no known sensible error. The average result obtained when all corrections had been applied, which were extremely complete, was the value of 776·94 foot-pounds as the mechanical energy measured at Manchester, equivalent to 1/180 of the heat necessary to raise 1 lb. of water from 32 deg. Fah. to 212 deg. Fah. The corresponding value reduced to the latitude of Greenwich is 777·07 foot-pounds, and the mechanical equivalent of heat expressed upon the basis employed by Joule is 773·74 foot-pounds, which should be compared with Joule's values in Table I., page 13.

This research, which Professor Lamb remarks "may claim to rank among the classical determinations of physical constants," was the last in mechanical science published by Reynolds.

The scope of the present paper has only permitted reference to one side of Reynolds's work. His contributions to physical science were no less original and profound. In general the basic character of much of his work is reflected by the continuous research, often at the hands of his students, that has sprung from many of his discoveries and ideas. The economic value of the engineering developments which are based directly or indirectly upon the results of his researches is immeasurable.

Researches Subsequent to Reynolds.—Since the carrying out of the researches which have been referred to, sufficient time has elapsed for their value to be assessed—the value in direct results and in influence upon the development of mechanical science. The work of Reynolds in particular has led to, or has been followed up by, many researches closely associated with the advances he made. In addition, important researches have been carried out in other directions, principally by living investigators. This work, however, is all comparatively recent. In view of its large extent, and the difficulty and inevitable uncertainty of attempting at present fully to assess its value and importance, it will only be briefly summarised here.

(*a*) *Researches Conducted in the Mechanical Engineering Department of the Manchester University.*—Several important researches may be found showing the direct influence of Reynolds, namely, work by Smith on the fatigue of mild and cast steels under high frequency of stress reversal, by Stanton on heat transmission through a metal wall separating two currents of water, and by Dunkerley on the critical speeds of loaded shafts. The last two researches have established permanent positions in their respective branches of mechanical science.

Reference should be made to a number of investigations upon the strength and behaviour of materials. Stanton investigated the plastic behaviour of wrought iron and mild steel stressed beyond the yield point, and Wilson measured the conjugate pressures in sand and their variation with the presence of water. An ingenious method of loading their test pieces enabled Robertson and Cook to explore, more accurately than had hitherto been done, the fall in resistance of mild steel immediately following the yield point. The last two workers also made a refined investigation of the failure of thick cylinders of mild steel and cast iron under internal pressure, their work constituting one of the most useful contributions to our knowledge of this subject. Later Cook investigated the distribution of stress in a pipe stiffened by rings or flanges formed in one with the barrel.

Attention has been given to the strength and stability of struts. Lander published a graphical method of determining the strength of struts and tie rods with lateral loads, and he has dealt with the stresses in the main spars of aeroplanes. Robertson made a critical examination of the published data on the strength of "pin"-ended struts, in which he referred the test results to the case of excentric loading. From these data, and the results of his own tests, which showed the importance to be attached to the yield point in compression of the material, he proposed expressions which appear to have a wide range of utility. Recently Robertson has published an important paper upon the strength of thin tubular struts for cases where failure occurs by wrinkling of the wall; a large part of the work for this investigation was carried out in Manchester.

In this country the early development and manufacture of internal combustion engines was centred to a large extent in and around Manchester. It is probable that manufacturers have carried out important investigational work, similar to that done on governing and described by Atkinson in a paper read before the Institution. Published research associated directly with internal combustion engine development is, however, not extensive, and most published Manchester researches on this subject were executed at Owens College. Petavel's work on solid and gaseous explosives is noteworthy on account of the range of pressures covered, and his employment of a specially developed recording manometer of high precision. Gibson and Gwyther investigated the influence of the degree of saturation of the air supply to a suction producer upon the performance of the plant, including gas engine. Petavel and Asakawa dealt with the influence of compression ratio upon the efficiency of a gas engine.

The intensive development of aircraft for war purposes led to research upon the working conditions in internal combustion engines. Gibson and Baker made some general investigations on exhaust valve and cylinder head temperatures and their dependence upon operating conditions; later Gibson investigated piston temperatures in a similar manner and compared values for aluminium alloy and cast iron pistons. More recently attention has been given to problems connected with the use of heavy oil engines for airship purposes. In this connection Mucklow has investigated the influence of reduced suction pressure and the use of hydrogen as an auxiliary fuel.

The prominence of researches in hydraulics due to Reynolds has been re-established during recent years by Professor Gibson, who has been responsible for most of the research in this branch of mechanical science subsequent to Reynolds. In 1908 Gibson published the results of a comprehensive analytical and experimental investigation of the phenomenon of water hammer in pipe lines and its relation to the regulation of water turbines. At about the same time he investigated the cause of the maximum speed of flow in a channel occurring below the free surface, and advanced a theory which accounted for the phenomenon and its dependence upon speed of flow and variation in the character of the channel bed. Gibson and Ryan investigated the resistance to rotation at high speeds of discs in water. Their data has enabled the frictional resistance and energy loss to be predetermined in most practical cases, as, for example, in centrifugal pumps and in water sealing glands of steam turbines. Two researches, one by Gibson and the other by Gibson and Labrow, have provided important information upon the loss of head associated with flow in a conduit of enlarging cross-sectional area. The former investigated straight conduits, and the

latter straight and bent conduits with radial regainers employed as draught tubes for water turbines. Reynolds's work and Rayleigh's more general deduction relating to the conditions of similarity of motion of fluids, have led to important experimental work upon the friction of liquids, gases, and vapours in pipes. Lander compared the resistance to flow of water and dry saturated and wet steam, in steel tubes, and confirmed the application of the principle of dynamic similarity. Gibson's investigation of the resistance of a corrugated pipe likewise provided striking support of the truth of the principle. An attempt by Heywood to correlate pipe and channel flow upon the basis of the principle, served the useful purpose of revealing the difficulties involved and the need for much further data. An important case of fluid flow is furnished by Cramp's investigation of the pneumatic conveyance of grain. At present considerable attention is being given in the department to the use and application of models in predetermining flow and behaviour in cases which are generally too difficult or laborious by analytical methods. An interesting example of the method is presented by Gibson's use of a model for investigating the behaviour of a surge tank upon a pipe line connecting a reservoir with a hydraulic turbine.

(*b*) *Researches Conducted in the Mechanical Engineering Department of the Manchester Municipal College of Technology.*—Researches at the College of Technology have been noteworthy for the considerable attention given to the behaviour of metal cutting tools. In 1902 the Manchester Association of Engineers appointed a committee to investigate the new rapid-cutting tool steels then being introduced, and a series of lathe tests upon different steels was carried out under Nicolson's supervision at the College of Technology. These tests, a report of which was made to the Association, gave a measure of the cutting capacity of the new steels when operating upon cast iron and carbon steels, but no attempt was made to investigate cutting action beyond finding in a preliminary way that when cutting steel the downward force upon the tool was proportional to the area of the cut, and that it decreased somewhat with increasing speed. Nicolson followed up these tests by conducting a series of tests using one particular tool steel to investigate the influence of tool form and cutting angles upon durability, and by means of a special dynamometer, he measured the component forces acting upon the tool. The results of this research were given in a paper read before the Institution in 1904. During the next eight to ten years researches were carried out in this country and abroad, but the results were not concordant, and the Manchester Association of Engineers formed a Lathe Tools Research Committee to institute research to establish with some degree of certainty the influence of the more important factors associated with cutting action. This research was carried out at the College of Technology with Mr. Dempster Smith—now Professor of Mechanical Engineering at the College—as investigator. Following a preliminary investigation, support was given to the research in 1915 by the Department of Scientific and Industrial Research, and a comprehensive programme of tests was commenced. This included investigation of heat treatment, various means for testing the quality and condition of tools, dependence of durability when cutting steel upon cutting speed, depth of cut, traverse, tool form, cutting angles, nose radii, size of tool, and use of a cooling medium. Also a full analysis was made of the component forces acting upon the tool and the power absorbed was determined. The results of this research were embodied in a report issued by the Department of Scientific and Industrial Research. This was followed by a second report, presented as a paper before the Manchester Association of Engineers, which gave results of a similar investigation when the material cut was cast iron. All these investigations were concerned with the removal of metal in quantity. Dempster Smith investigated the behaviour in the case of fine cuts, and the results of his tests were published in two papers. In the first, by Dempster Smith and Hey, the existence of maximum durabilities found by Herbert was confirmed, and in the second, by Dempster Smith and Leigh, the superiority of a plain carbon tool steel over a high-speed tool steel for fine cuts was demonstrated.

So far, reference has only been made to research upon lathe or single cutting edge tools. An investigation upon the forces acting upon twist drills was commenced by Nicolson and completed by Dempster Smith and Poliakoff. The results obtained were embodied in a paper read before the Institution, and have provided valuable information upon the forces associated with drilling.

Nicolson carried out an important and extensive research upon heat transmission associated with high gas speeds. With the object of greatly increasing heat transmission rates by appropriately raising the gas speed, he investigated the applicability of Reynolds's law to heat transmission in boilers. Heat transfer from compressed air to water through a metal wall was investigated first at the College of Technology and later at the works of Messrs. Joseph Adamson and Co. Further experiments, using both compressed air and superheated steam, were carried out by Nicolson, Jordan, and others at the College of Technology. These experiments and existing data enabled values to be assigned to the coefficients of Reynolds's formula expressed in terms of the magnitude of the hydraulic mean depth of the conduit and the temperatures of the gas and of the metal wall. This important investigation was followed by research at the works of Messrs. Joseph Adamson and Co., upon a specially constructed Cornish boiler. The results of the tests demonstrated the applicability of Reynolds's law and, in accordance with the law, rates of heat transmission were obtained many times those occurring in normal practice, or, indeed, imaginable upon the knowledge existing prior to the advance made by Reynolds.

Mellanby was responsible for an important research upon the influence of steam jackets on the efficiency of compound steam engines. The results of this research, which provided a concise and convincing determination of the influence of steam jackets situated at different parts of the cylinders, were given in a paper before the Institution.

The most important research relating to heat engines with which the College of Technology has been associated is the Steam Nozzles Research of the Institution. This research, which is being carried out in Manchester, was commenced in 1920, Dr. Stoney acting as reporter and Dr. Telford Petrie as superintendent of research. Five reports have been issued by the Institution. Their subject-matter is so well known and recent, however, that no particulars are necessary, but it should be recorded that the results obtained have been of very considerable value in their influence upon steam turbine development. In view of Reynolds's important and original contribution upon the flow of gases in passages and nozzles it was appropriate that Manchester should have been chosen as the centre for the Institution's researches on this subject.

Reference should be made to researches by Dempster Smith and Walker upon the flow of water through orifices and over weirs. Stoney has drawn attention to the fact that in the case of the first investigation the results lend support to a prediction of Mr. H. M. Martin regarding changes in the velocity coefficient for steam flow in nozzles at low speeds. An important investigation by Stoney, Boswall and Massey, upon oil film thickness in the case of cylindrical bearings, gave results in reasonable agreement with theoretical values derived from Reynolds's theory of lubrication.

Researches relating to the strength and elasticity of materials which may be referred to include Carrington and Popplewell's investigation of the strength of short thin-walled tubular struts where crumpling of the wall is the mode of failure; Carrington's investigations of the physical properties of spruce, of the bending of deep beams, and of the deflexion and vibration characteristics of thin plates.

(*c*) *Other Researches.*—In connection with Manchester's pioneer position in this country in researches relating to the cutting of metals, the work of Mr. E. G. Herbert requires reference. In 1909 Herbert published the results of an investigation into the cutting action of files, which included continuous cutting tests with light cuts. His results showed the superiority of carbon steel over high-speed steels at low cutting speeds and light cuts, and demonstrated that for a given cut a maximum cutting capacity occurred at a particular speed. During the last three years Herbert has presented to the Institution several important papers dealing with the cutting of metals. These are so recent, however, that their character and contents will be familiar to members.

Reference should be made to the Manchester Steam Users' Association, partly because of the useful investigation this Association has carried out, and also because of its pioneer character as an organisation of industrial concerns having as one of its objects the prosecution of research for the benefit of its members. From the time of its foundation in 1855 by Fairbairn until the appointment in 1897 of Mr. C. E. Stromeyer as chief engineer, the Association carried out a number of investigations of a practical character, although in the later years of this period there was a decline in its research activities. The appointment of Stromeyer was marked by a revival of the research policy of the Association. After dealing with the problems of boiler incrustation, and water treatment, and the causes of embrittlement of steel in steam boilers, Stromeyer gave attention to the subject of fatigue, and in 1914 he presented an important paper embodying the results of his reaserch. His tests were made in torsion, by means of his special testing machine, now installed at the National Physical Laboratory. He introduced a thermal method of studying the progress of fatigue and of obtaining endurance values. Failure by fatigue is often closely associated in practice with stress concentration. Stromeyer developed a delicate strain gauge for the purpose of determining stresses at fillets, corners, and plate surfaces. He has applied his method, for example, to determine the stress distribution at the corners of a locomotive fire-box, and recently Dr. Telford Petrie, the present chief engineer, has used the method to investigate the distortion of a Lancashire boiler.

Conclusion.—The author has endeavoured to give an outline of Manchester's contribution to mechanical science as represented by its published researches. It may appear that during the last century the stage was occupied by a few men of outstanding genius who made notable advances in the science of engineering. Although time, by submerging the commonplace, sets in relief the contributions of lasting merit, the period was certainly characterised by a few men of remarkable achievement. We are too close to the contributions made during the present century to obtain a correct perspective of their value, and it would be invidious even if it were possible to make comparisons with the past. Life has become more strenuous, the demands upon thought more various, and the question may be raised whether present conditions encourage or permit the continued concentration upon a subject which characterised the major researches of last century.

It has been suggested that the researches to which reference has been made fall broadly into two periods. We are now witnessing the early stages of a third period in which industry, recognising the advantages it has received from the scientific research of the past and realising the greater need of the future, is itself energetically prosecuting research as an economic necessity. This is taking the form of extensive co-operative research, represented by the research associations of specific branches of industry, which have been formed and are assisted financially by the Department of Scientific and Industrial Research, and by the creation by some engineering firms of their own research organisations. These in many cases are beyond the development stage and have established their values. Upon some future occasion of reviewing the contributions made by research to engineering science it will be necessary to include the work of these organisations. The hope may be expressed that their contribution will be found worthy of the example and inspiration of the researches to which attention has been drawn.

[The paper concludes with an admirable and exhaustive bibliography.]

NEW ROLLING STOCK ON THE LONDON UNDERGROUND RAILWAYS.

THE London Underground Railways have issued the following information regarding the new rolling stock which is being put into service :—

The withdrawal of the original type of tube car, with hand-operated gates, and the substitution of modern cars with air-worked doors was completed some time ago on the Central London and the Hampstead and City Lines, and now the Piccadilly Line is undergoing a similar process of conversion. The old cars which, were of French and Hungarian construction, have been in service since the opening of the line at the end of 1906, over twenty-three years ago, and it is estimated that they have carried 1,250,000,000 passengers during that time. Although the Piccadilly Line is the third of the lines to be fully equipped with new cars, it was the pioneer in the matter of pneumatically operated doors. It was on it that at the end of 1920 the doors were first experimented with under service conditions, and a year or so later sixty cars embodying the new method of door operation were put into service, and are still in use. The first of the new air-worked door trains made its appearance on the Piccadilly Line in March last. Sixteen are now in service, and the change will be completed this week-end.

It is pointed out that the main feature of the cars is the door arrangement, since it provides a spaciousness which adds greatly to the comfort and speed of the user, particularly the short-distance passenger, who can remain in the vicinity of the doors without causing obstruction. Improvements in lighting, ventilation, seating arrangement, and upholstery are embodied, and smoother riding is afforded by a new type of truck. The new motor equipment and the saving in time at stations have already enabled an increase in speed to be made on Sundays and during the slack hours on week-days.

The last Line to be dealt with will be the Bakerloo, and it is anticipated that the conversion of the local trains on that Line to the new type will be completed by December. The whole of the Tube Lines will then, in the short space of three years, have been completely changed from old stock to new stock; 1343 cars of the new type will have been put into service at a cost of approximately £2,225,000.

On the District Railway also new cars of a greatly improved pattern are being put into service, together with reconditioned cars, at the rate of a train a week. The whole of the Main Line service will be comprised of new and converted cars early next year.

AIRCRAFT APPRENTICES FOR THE ROYAL AIR FORCE.

THE Air Ministry announces that 600 aircraft apprentices, between the ages of 15 and 17, are required by the Royal Air Force for entry into the schools of technical training at Halton, Bucks., and at Cranwell, near Sleaford, Lincs. They will be enlisted as the result of an open competition and of a limited competition, which will be held in the near future by the Civil Service Commissioners and the Air Ministry respectively. Successful candidates will be required to complete a period of twelve years' regular Air Force service from the age of 18, in addition to the training period. At the age of 30 they may return to civil life or may be permitted to re-engage to complete time for pension.

Full information regarding the dates of the respective examinations, the methods of entry and the aircraft apprentice scheme generally, can be obtained if early application is made to the Royal Air Force, Gwydyr House, Whitehall, London, S.W. 1. In this connection, the sons of officers, warrant officers and senior N.C.O.'s of the three services receive special consideration. The scheme offers a good opportunity to well-educated boys of obtaining a three years' apprentice course of a high standard, and of following an interesting technical career. Already over 5000 aircraft apprentices have completed their training at the technical schools of the Air Force, and the annual output is approximately 1000 fully trained aircraftmen.

The principal trades open to boys are metal rigger, a new trade brought into existence by the introduction of the metal aeroplane, which involves training in both fitting and sheet metal work; fitter (aero-engine); fitter (driver, petrol); fitter (armourer); coppersmith and metal worker; wireless operator-mechanic and electrician. The apprentices are given a thorough training in their trade by highly qualified technical instructors and their general education is also carried on simultaneously by a staff of graduate teachers.

During the training period the rate of pay is 1s. a day for the first two years, and 1s. 6d. a day thereafter until the apprentice has both attained the age of 18 and been posted to a unit on completing his training. When he is posted to a unit for duty as an aircraftman, the commencing rate of pay varies from 3s. 3d. to 5s. 6d. a day—22s. 9d. to 38s. 6d. a week—according to the marks obtained in the passing-out examination. He also receives free board and lodging. A few apprentices of special promise proceed to the Royal Air Force College for training with a view to becoming Commissioned Officers. For the remainder, opportunities arise later to volunteer to qualify in flying and become airman pilots. Selection to the number of over 100 is made annually from volunteers of all trades. From amongst airman pilots a few are periodically selected for commissioned rank.

CONDITIONS FOR CONTRACTS.—Users of the model forms of general conditions for contracts issued by the Institution of Electrical Engineers are reminded that revised editions have been issued as follows :—Form A (home, with erection), April, 1929; form B1 (export-delivery, F.O.B.), December, 1928; form B2 (export, including erection or supervision of erection), December, 1928. In addition, there are available :—Form C (sale of goods other than cables—home, without erection), issued April, 1924; form D (sale of cables—home, without erection), issued April, 1924.

CONGRESS OF METALLURGISTS IN DUSSELDORF.—As already announced, a congress of metallurgists is to be held in Düsseldorf from September 9th–12th, and up to now nearly two hundred persons from all over Europe—and some from America—have indicated their intention to participate in the gathering. The congress will comprise :—(*a*) The presentation and discussion of about fifteen scientific and practical papers relating to metallurgical work; (*b*) visits to works in or near Düsseldorf and Berlin; (*c*) receptions, dances and other social gatherings. Persons who desire to participate in the congress should write for particulars without delay to the secretary of the Institute of Metals, Mr. G. Shaw Scott, M.Sc., 36, Victoria-street, London, S.W. 1.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Pig Iron Surprise.

THE decision of the Central Pig Iron Producers' Association to reaffirm prices on the recent basis came as something of a surprise to industrialists in the Midlands and Staffordshire, who had quite made up their minds that the blast-furnacemen would seize the opportunity afforded by the conditions existing in the industry, as outlined in this letter a week ago, to secure an advance in selling rates. Consumers of pig iron had been paying premiums amounting to as much as half a crown for supplies—and, it may be added, are still doing so—and they quite expected the basis price to be raised to that extent. The resolution passed by the Association as communicated to the Press makes interesting reading, and puts the matter "in a nut-shell." It reads: The Association "whilst recognising that the prevailing prices of pig iron are substantially higher than the basis which they have fixed, have decided, as a matter of principle and for the purpose of encouraging trade, not for the present to increase the minimum basis." When the decision became known, business halted for a time, consumers hardly knowing how to interpret the Association's action. There were those who put it down to a weakness in the controlling organisation. Inquiries elicited the fact that the Association basis was regarded by sellers merely as a minimum, and they pretty generally asked advances on the basis quotations. Little business has been transacted this week, but what has been done, has for the most part been put through at prices on a higher level than the basis. Users have in most instances little cause to go on to the market, having covered themselves for some time to come, as is clearly demonstrated by the fact that practically all the Midland smelters have sold their output over the next three or four months. The difficulty of fuelling more blast-furnaces puts a limitation on output, and this fact, coupled with an increasing consumptive demand, places blast-furnacemen in a happy position, so that they are chary at entering into further commitments, even at the higher rates now being conceded. Smelters and merchants have done some business again this week, with the Cleveland district, chiefly with Northamptonshire brands of material. Consumers are concerned as to the future and are watching events very closely.

Steel.

Business in the steel branch of the market is "just jogging along." In the finished department orders are scarce and irregular, and are for small tonnages when received. Structural engineers are not consuming very large quantities of joists at date, and the requirements of the rolling stock establishments have been, to a large extent, foreseen and contracts for material entered into some time ago. The steel mills have fair orders on their books, and are carrying on with little anxiety or worry. Prices remain unchanged. Makers of half products are selling their outputs at good prices. Consumptive requirements appear to be steadily advancing, and with high foreign prices the bulk of the business comes to native steel masters. Small steel bars are obtainable at £8 5s., but the order must be substantial to be accepted at this price. Billet prices are maintained and vary from £6 10s. asked by Welsh makers to upwards of £6 15s. quoted by English mills. There has been a rise of 5s. per ton in the quotation for foreign steel tube strip, bringing the delivered price to £7 15s. per ton. English material can be bought at £8. Generally speaking, there is no advantage in buying foreign semis at date. Special steels are in good demand amongst the makers of motor cars and heavy commercial vehicles. Good tonnages have been purchased in this district and works producing this material are busy.

Staffordshire Bar Iron.

Production of Staffordshire bars continues at about the same rate as recently. There has been no change of any importance in the trade during the week, business going steadily ahead. Crown bar mills persist in their endeavour to maintain a standard of £10 per ton, but the competition from outside districts makes this extremely difficult. Competition from the Continent in the nut and bolt bar department is unabated, and local makers are securing very little business. Their price of £9 odd compares unfavourably with Belgian offers of No. 3 iron at £7 2s. 6d. Although there has been some falling off in inquiries for wrought iron tube strip, the mills are kept going steadily at date, and the selling figure is upheld at £11 per ton.

Fall in Sheet Values.

Sheet mills are eager for orders, and as a result there has been some lowering of the market value. Galvanised corrugated sheets of 24 gauge are now on offer at £13 10s., half a crown lower than makers would have accepted a week ago. There are a few mills who are fortunately so placed that they are able to maintain their quotation at 5s. per ton above this selling figure. They are not booking much new business, but they can afford to await a rise in the market level.

Scrap Prices.

Heavy steel scrap prices are tending higher again, due no doubt to the shortage of basic pig. A week ago £3 17s. 6d. was accepted by sellers for delivery to South Wales. This week £4 per ton was demanded, and paid. Supplies are not easy to obtain, even at that figure.

Safeguarding.

Many Midland manufacturers, iron and steel masters and some engineers, notably those associated with the automobile industry, were staggered at the Premier's announcement that in no case would the Government renew existing safeguarding duties, and dismayed at his further pronouncement that it would reserve the right to repeal them at earlier dates than those fixed for their expiration. In this area hundreds of manufacturers are interested, either directly or indirectly, with safeguarded industries, and they have witnessed the growth of the automobile trade and sections of the hollow-ware trades under the protective duty. They fear a repetition of the retrograde movement which set in when the McKenna duties were repealed some years ago. While the Government's pronouncement is appraised in some circles, it is fairly safe to assert that the majority of Midland and Staffordshire manufacturers condemn it and honestly believe it spells, if not ruin to their industries, at least a severe check to the progress which has this year been made towards placing them on an economic footing.

Bright Future Prospects.

Sir John Field Beale, chairman and managing director of Guest, Keen and Nettlefolds, Ltd., speaking recently in Birmingham of the future prospects of his company, stated that this year the difficult trading conditions which had been experienced by the industries in which they were concerned had the appearance of becoming less in many directions. He referred to the assistance they were anticipating from derating, and said that not only would it be of great help to his company directly, but indirectly, by the great stimulus it would give to trade in all directions throughout the country. He looked forward to a period of increasing prosperity. Industrialists hereabouts were pleased to have Sir Field Beale's assurance that all Nettlefolds' group of works in the Midlands—which, he said, constituted the highly finished products section—were giving a good account of themselves, and, without exception, the company was satisfied with their development since coming into its hands.

Blast-furnace Closes Down.

The Lilleshall Company has closed down its blast-furnace at Priorslee, adding a further 150 men and boys to the unemployed. It should be pointed out that the company produces a very high-class iron, the call for which has fallen off during past years, so that the taking out of action of this furnace is not a matter of grave importance to the material market. Before the war two of the company's three furnaces were kept going, one being reserved for blowing. During the last eight years, however, only one has been in operation, so that it will be seen the activities of the blast-furnaces have been limited, and the blowing out of this furnace ends, at any rate for the time being, the firm's activity in the production of pig iron. It is unauthoritatively stated that there are some 12,000 tons of pig iron in stock.

Rolling Stock Contracts.

It gives much satisfaction to industrialists in this area to learn that Midland rolling stock firms are meeting with much success in competing against the United States and European countries for orders from overseas railway companies. They offer their congratulations to the Birmingham Railway Carriage and Wagon Company, Ltd., on securing an order for 150 wagons for the South African Railways, and to the Metropolitan Cammell Carriage, Wagon and Finance Company, which is to make 250 wagons for the railways of the same country. The combined orders are of the value of £160,000.

Hams Hall Power Station.

Work on the Birmingham Corporation super-power station at Hams Hall, near Coleshill, is advancing steadily. The first boiler is now under steam and the first 30,000-kW turbine has been started up. Members of the Birmingham Electric Supply Committee have just paid a visit to the station to see for themselves the progress being made, and they anticipate, I learn, that the first generating set will be ready to go into service in time to take the next winter load.

Loss on Cannock Chase Coal.

The ascertainment of the proceeds of the Cannock Chase and Pelsall coalfields during the three months ended May shows a loss of 1s. 1·18d. per ton on all coal produced, compared with a loss of 9½d. per ton during the previous period. Miners' wages this month will stand at 42 per cent. above the 1911 wage basis, although the ability of the industry to pay is only 31·06 per cent. The minimum wage of stallmen will be 9s. 4d. per day.

Unemployment.

Unemployment in the Midlands area continues to mount, notwithstanding the more active conditions prevailing in the heavy industries in the district. The past week has witnessed a further increase in the number of workless persons of 2701, bringing the total up to 160,103. To this total, Birmingham contributes 22,146; Coventry, 4275; Stoke-on-Trent area, 19,492; Nottingham, 7260; Leicester, 6303; Wolverhampton, 5438; and Walsall, 4538. The following Black Country towns showed decreases:—Bilston, Oldbury, Smethwick, Tipton, and West Bromwich.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The Invasion of the Omnibus.

IF the Manchester City Council acts on the recommendation of the Tramways Committee, the motor-omnibus will have marked a successful penetration here into the province of the tramcar. Express omnibus services have for some time been running on various long-distance routes through the city into the suburbs, and have been increasingly successful from the point of view of public support. In all cases, however, the services have been in the nature of auxiliaries to the tramcars. The latest proposal is for the motor-omnibus to replace the tramcar entirely on one particular route, over eight miles long, where the existence of several railway bridges enables only cars of the single-deck type to be run. These naturally are of low-carrying capacity compared with the double-deck cars generally employed on all other routes. The proposal of the general manager of the department is to substitute double-deck, top-covered omnibuses, having a seating capacity for fifty-one passengers. It is estimated that sixty of these, costing altogether about £105,000, would be sufficient to maintain an efficient service.

Gas Manufacture Less Profitable.

A remarkable falling off in the net profit of the undertaking is disclosed in the annual report for the year ended March 31st last of the Manchester Corporation Gas Committee. From £388,269 in 1927–28, the profit has declined to £202,834 for the past twelve months, owing, to some extent, to an increase in income-tax payments from £1852 to £64,928. There was an increase of 0·96 per cent. in the quantity of gas consumed, the total being 7,141,047,000 cubic feet, although there was a drop in the average selling price to 3s. 5·46d. from 3s. 8·7d. in the previous year. A successful innovation has been the supply of a graded coke for domestic consumption, sales having expanded from 265,000 cwt. to 420,000 cwt.

£2250 or £1500?

The Gas Department, having made up its mind after a good deal of controversy to appoint an engineer, as distinct from the former joint position of general manager and engineer, is finding the task not an easy one to carry out, and a situation which is not without its humorous features has developed. It was decided to appoint a commercial manager and an engineer. The former position was filled, and a salary of £1500 was attached to the office of engineer. It was discovered, however, that that figure did not attract what were regarded as suitable candidates, and on further consideration the City Council increased it to £2250, but the revised "short list" contained the name of only one man who had not previously applied for the position at the lower figure, and he subsequently withdrew his application.

Airport Developments.

The contract for the construction of a hangar and workshops for the Manchester municipal aerodrome at Chat Moss, which is expected to be ready for the formal opening at the end of September, has been placed by the Corporation Aerodrome Committee with E. Marshall and Sons, Ltd., Ashton-under-Lyne. In a report to the Liverpool City Council, the town clerk, Mr. Walter Moon, says that the possibility of constructing a combined aerodrome and seaplane station has been under discussion, but no site possessing the necessary physical advantages has been found. It is further stated that the cost of building a seawall and constructing a marine lake at Speke would be so high as to render that suggestion impracticable.

Courtaulds and Preston.

Courtaulds, Ltd., has decided to exercise its option to purchase a works site at Ribbleton, Preston, and to erect an artificial silk factory when the demands of the trade justify it in doing so. The construction of the works would mean a new sewer to carry about 2,000,000 gallons of effluent a day to the outlet at the docks. It is expected that employment would be found for 4000 or 5000 people, with the possibility of the number growing eventually to 9000 or 10,000.

Non-ferrous Metals.

There has been a relatively important gain on balance for the week in the tin section of the non-ferrous metals market, but copper, lead and spelter have all shown declines of varying extent, and, on the whole, buying interest has been less in evidence. With regard to copper, business in the standard market has been on a reduced scale, although a moderate demand has been experienced for forward refined metal for the cable-making industry. The lower level of prices in this section of the market is a reflection of the fact that the supply position at the moment is less restricted than it has been of late, quotations for standard brands being lower to the extent of 15s. to 20s. a ton, according to position. Tin has strengthened somewhat, and at the moment of writing is not much below the recent high level recorded early in June, values having advanced on the week by from 25s. to 30s. a ton. This, however, has been less the result of any activity in the demand than of a temporary decline in offers. Interest in lead has been rather slow, and after a steady period prices have declined by about 10s. a ton, bringing current rates back to where they were about the middle of March, immediately before the steep rise which set in. Supplies of spelter are still more than sufficient to meet the demand and prices on the week are appreciably lower in consequence.

Iron and Steel.

The fact that Lancashire foundries have been less active buyers of pig iron for forward delivery indicates no weakening of the position. Sellers have been anticipating a slackening off, for the latest spurt has been sustained for a longer period than was expected, and sooner or later, of course, it was bound to diminish. As it is, Midland producers are probably better booked than they have been for a long time, and the tonnage being specified for continues at a relatively satisfactory level. Manchester zone prices have not been officially advanced, but there is a growing tendency to ask a shilling or more above the minima. Values are therefore more or less nominal at 73s. for Staffordshire, 72s. for Derbyshire, 91s. to 92s. for Scotch, and about 86s. 6d. for hematite, all delivered Manchester. In steel, locomotive builders continue to take fair quantities of material against contracts, and bright-drawn bars are also in active demand. There has been no general improvement, however, in the rate of deliveries to constructional engineers. Small re-rolled steel bars are being quoted here at down to £8 5s. per ton,

with sections at £8 2s. 6d., large bars at £9 2s. 6d., boiler plates at £9 12s. 6d. to £9 17s. 6d., and general plates at £8 17s. 6d.

BARROW-IN-FURNESS.

Hematite.

The position in the hematite pig iron market is satisfactory, and makers are well fixed for orders. Apart from the steady demand for iron on local steel account business generally with buyers continues to be firm, and producers are well booked forward. The output for the next three or four months is covered by orders held at present. The twelve furnaces which are in blast are not likely to be increased, for the present demand does not merit a further increase in production, neither do future prospects suggest the likelihood of increased production being necessary. The weak point in the trade is the demand from the local steel makers. If steel was in big demand and works were assured of a steady run on full time for many months ahead, it would be different. In special qualities there is a good business not only with home buyers but also with American and continental buyers. Iron ore remains about the same, with outside trade maintained. The steel trade is fairly well employed at present, but the market is not over bright, and competition for big orders is keen, the price not allowing of much margin. Hoops keep in regular demand, mostly on overseas account.

Shipbuilding.

The Admiralty submarine depôt ship "Medway" is now almost ready for delivery. She is at present on the point of completing her fitting out at Barrow. She is 580ft. long, and has a moulded breadth of 85ft. The B.H.P. is 8000. She is driven by twin sets of M.A.N. double-acting engines built at Barrow by Vickers-Armstrong. Apart from her own bunkers she can carry 2000 tons of fuel supply, and there is accommodation on board for submarine officers and men whose vessels may at any time be lying alongside. Her repair workshop is very extensive, as may be judged from the fact that there is auxiliary machinery with a dynamo output of 2800 kW., which is developed by five Diesel engines with coupled dynamos. The vessel, which is painted white, presents a most striking appearance, and is a great advance on any previous craft of this kind.

SHEFFIELD.

(From our own Correspondent.)

Conditions in the Steel Trade.

OWING to the approach of stocktaking, many consumers of steel have kept down their purchases to the lowest level, and consequently a quieter time has developed in several sections of local trade. These are chiefly the branches devoted to ordinary lines of manufacture. Special departments continue busy, and a large amount of valuable trade is on hand in connection with automobile requirements, stainless and non-corrodible steels. For tools of best quality, increased bookings are reported, but firms which have not maintained a high standard of quality are not so well placed. The demand for basic steel continues very brisk. One of the best employed establishments in the district is that of the Parkgate Iron and Steel Company, where practically full time is still being run; and there is a fair amount of work on hand at the River Don Works of the English Steel Corporation, and Brown Bayleys' steel works. In North Lincolnshire, activity has reached the boom stage. John Brown and Co. has blown in a second pig iron furnace at the Trent Works, Scunthorpe.

Railway Material.

The condition of the acid steel branch is very different from that of the basic. Demand is very poor, and many furnaces are idle. The call for railway material, which usually takes a large tonnage from this side of the trade, keeps very low. Bulk orders from the British railway companies are absent, and hardly any wagons are being built for private owners, while buying from overseas is very limited. At the meeting of John Brown and Co., the chairman stated that some of the home companies were extending the production of certain classes of railway material at their own shops. One order reported this week, which concerns a local company, is for 250 railway wagons for South Africa. These vehicles will be made by the Metropolitan-Cammell Railway Carriage, Wagon, and Finance Company, and a further 150 wagons are to be supplied by the Birmingham Railway Carriage and Wagon Company. The total value of the 400 wagons is given as £160,000.

More Rationalisation.

The reduction in the volume of orders for railway axles and tires is presenting a serious problem to manufacturers. Modern tire plants are so expeditious that capacity is now far ahead of requirements. In consequence, increased attention is being paid to the question of rationalisation. I have already reported the closing of the tire plant at the Penistone Works (Cammell, Lairds) of the English Steel Corporation, and the transference of the work to Manchester. Now comes a proposal for the amalgamation of two firms which will have a similar result. John Baker and Co., of Rotherham, has offered to buy the whole of the issued share capital of the historic firm of Henry Bessemer and Co., of Sheffield. Both firms are makers of tires and axles, and Bessemers' tire plant is comparatively new. Bakers, in their letter to Bessemers, say that "the large number of manufacturers and the small and declining demand for tires and axles is the cause of the present unsatisfactory state of the industry, and unless some drastic steps are taken the outlook for the future is most unpromising." They suggest rationalisation as the best way of meeting the difficulty. "The prospect will be vastly improved," they say, "if your work and ours is done in the same factory, because the establishment charges would be spread over a larger output, and the ratio of profit per ton would be much larger. The capacity for output in our factory is quite sufficient to deal with the output of both firms." The directors of Bessemers recommend their shareholders to accept Bakers' offer. They remark that "owing to various causes, the capacity of existing plants to supply tires and axles, this company's principal product, is largely in excess of the demand. This shortage of work is inevitably reflected in steadily shrinking prices and increasing losses all round. The difficulty of the situation is now intensified so far as this company is concerned by recent amalgamations of rival firms and by the failure or absorption of some of the company's main customers." It may be taken as pretty clear from these statements that if the proposed deal is carried through, Bessemers' axle and tire plant will be shut down and the work transferred to Rotherham. Bessemers are also noted makers of high-class steel forgings, such as crank shafts. Whether their works will continue to make these forgings or will be wholly closed is not yet determined.

Browns and the Combine.

It may be that we are about to see an important extension of the English Steel Corporation, that great combine which was recently formed to incorporate the steel and allied businesses of Vickers-Armstrongs at Sheffield and Openshaw, Cammell Lairds at Sheffield and Penistone, and Taylor Brothers at Manchester. Lord Aberconway, speaking at the annual meeting of John Brown and Co. last week, said they had been invited to go into the combine, and for the last few months the directors had given constant and most minute consideration to the details of the scheme and the effect upon the firm of the proposed reorganisation. The question was now approaching a decision, but as it involved subjects of great delicacy he asked shareholders not to press for further details at the moment.

A Lincolnshire Acquisition.

It is reported that negotiations have been almost completed for the purchase of the Ardsley Ironworks and Tingley Collieries, Morley, by the Frodingham Iron and Steel Company, which is controlled by the United Steel Companies, Sheffield. The Morley works were closed at the end of last year. It is understood that the object of the Frodingham Company is to acquire possession of the ironstone mines at Scunthorpe, which belong to the Morley undertaking, and that in the event of the purchase being completed the colliery and ironworks will be disposed of for dismantling and breaking up.

Cutlery and Plate.

The condition of the cutlery and plate trades shows little improvement, and in only a few cases are firms able to report favourably on their position. On the whole, production shows a considerable falling off as compard with a year ago. Financial stringency is increasing the troubles of the trades. There is a growing difficulty in obtaining payment of accounts, and this especially affects makers of expensive sterling silverware. The production of this ware entails heavy initial outlay. There are a number of inquiries afoot for silver goods, but these large orders cannot be financed by every firm. The restricted number of spinners available also handicaps the trade. An interesting question regarding standardisation of patterns is raised by a report from Germany. That country's exports of cutlery to the United Kingdom during April amounted to the record quantity of 70·4 tons, which was much higher than during any month before the import duty was introduced. The value per ton of cutlery sent to this country is constantly increasing. According to the Solingen industry, the high export figures to England are due to the fact that Sheffield has paid too much attention to standardisation and rationalisation, and the catalogues of the average Sheffield firm contain little choice, as compared with the wide selection afforded by the German catalogues. In Sheffield, standardisation and reduction of patterns has been advocated as a means of solving the main problems of the cutlery trade, but it appears that the Germans disagree with such a policy, and that they are gaining trade by following an opposite course.

The Cheapest Electricity.

The claim to have sold electricity at the lowest figure recorded by any electrical undertaking in the country is made by the borough electrical engineer of Rotherham in his report on the past year's working. The figure given is ·746d., which was the average price received for current during the year. In the previous year it was ·892d. Another striking figure is that of total works costs, which have been reduced from ·427d. to ·357d., the latter amount being a record, not only for Rotherham, but for any undertaking, either municipally or company owned, throughout the country. The cost of generation per unit sold decreased from ·269d. to ·225d. The number of consumers has increased from 6593 to 9170; the kilowatts connected from 58,323 to 60,442; and the quantity of electricity sold from 63,561,013 to 80,258,345 units. There was a net profit for the year of £30,322.

Crossing the Humber.

A conference of local and county authorities in Yorkshire and Lincolnshire was held at Hull last week to discuss the question of tunnelling or bridging the Humber. It was decided to seek an interview with the Minister of Transport (Mr. Herbert Morrison), and Mr. J. H. Thomas (Minister in charge of employment schemes), in order to obtain their opinions regarding the prospects of Government support. The Town Clerk of Hull, who recently interviewed officials of the Ministry of Transport, informed the conference that the Ministry would not entertain the idea of receiving a deputation unless it could appear before the Ministry with plans and a practical scheme, the cost of preparing which would probably amount to £2000, towards which there were some grounds for believing that the Government might be prepared to make a substantial contribution. It was decided to suggest to the authorities represented that they should elect representatives to form a committee of inquiry, with power to appoint expert engineers to prepare plans and advise on the best means of establishing communication across the Humber between the two counties.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Trade Revival.

A RETROSPECT of the past half-year's trading reveals a gratifying expansion in the iron and steel industry in the North of England, and it is not only likely to be sustained but promises to bring more producing plant into operation. Exports have increased, imports from abroad have been reduced, and, above all, there has been a slight advance in selling prices, which should ultimately be reflected in improved financial returns for long-suffering shareholders. In the Cleveland district the number of operating blast-furnaces has been increased since the beginning of January from thirty-one to forty-four at the present time, and so soon as difficulties in regard to the permanent expansion of supplies of raw materials can be overcome, at least another half-dozen blast-furnaces will be put into commission. But for the restrictions imposed on the export trade owing to the pig iron famine, it is probable that the June shipments from the Tees would have reached 100,000 tons for the first time for over two years. Makers, however, have had to refuse foreign business, and as a result pig iron exports, which in a period of four months had more than doubled, declined from 32,718 tons in May to 24,182 tons in June. Manufactured iron and steel shipments are maintained at a slightly higher level than in 1918. In May the total was 63,524 tons and in June 64,373 tons. The increased steel tariff in India has led to a contraction of the Indian trade, but South and East Africa are taking a heavier tonnage of Cleveland's steel, and so, too, is the Argentine, where a valuable and increasing trade has been cultivated.

Cleveland Iron Trade.

The need for an additional output of Cleveland pig iron is urgent. For some weeks past famine conditions have prevailed, and at the moment it is almost impossible to purchase even a ton of iron on the market for early delivery. The obstacles to enlargement of output are as formidable as ever. Idle plant would be put into operation if ironmasters could be assured of sufficient supplies of ironstone and coke to justify the re-kindling of inactive blast-furnaces. Makers still hold aloof from the market, and local founders are now being compelled to make rather extensive use of Midland iron. Further purchases from that quarter are not unlikely. Continental consumers will not pay the rates named for Cleveland pig iron, but home consumers do not hesitate to buy at the prices asked, and any small parcels that come on to the market are quickly snapped up. No. 1 Cleveland foundry iron is 75s.; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; and No. 4 forge, 71s.

Hematite Pig Iron.

A steady home and continental trade is passing in East Coast hematite pig iron, and prices are gradually rising. Values are, however, still at a comparatively very low level. Makers are well sold, and second-hands are understood to have arranged a few moderately good contracts recently. Orders for ordinary qualities are now rather difficult to place at 74s. 6d., and several sellers are holding out for 75s. No. 1 quality is at a premium of 6d. per ton.

Ironmaking Materials.

In the foreign ore trade merchants are not in a position to offer anything like extensive quantities for early delivery. Consumers have made heavy contracts, but owing to scarcity of suitable cargo boats, supplies coming forward fall considerably short of what could be desired. Quotations are based on fully 23s. 6d. for best Rubio c.i.f. Tees. Coke requirements are growing, and the addition to the output is not likely to be on a scale sufficient to satisfy users. Good average blast-furnace qualities are quite 21s. delivered to North-East Coast works.

Manufactured Iron and Steel.

There are no quotable changes in the manufactured iron and steel trade. Finished iron firms are turning out a lot of work and are booking a few orders. The semi-finished steel department is an active market, and would be even more so if supply were greater. In their unsuccessful endeavour to cope with demand, producers are running plant at as high pressure as circumstances permit. Continental material is not being extensively purchased, but consumers are having to draw supplies from other home areas, and substantial orders for steel slabs are stated to have been placed with manufacturers at a distance from Tees-side. Demand for finished steel is somewhat irregular, but works are well employed.

Iron and Steel Imports.

Imports of iron and steel to the river Tees from foreign countries continue to dwindle. Statistics presented at this week's meeting of the Tees Conservancy Commission showed that during the eight months ending June 30th, 119,616 tons were imported, as compared with 151,037 tons in the corresponding period of 1927–28 and 47,944 tons in 1913–14. The pig iron imports totalled 19,381 tons, as compared with 4908 tons in 1927–28 and 218 tons in 1913–14; and the imports of plates, bars, angles, rails, sheets, joists, &c., reached 34,227 tons, as against 31,200 tons and 17,419 tons. Crude sheet bars, billets, blooms, slabs, &c., unloaded in the port totalled 66,008 tons, as compared with 114,909 tons and 30,307 tons respectively.

The Coal Trade.

The improvement in the Northern coal trade is fully maintained. Inquiries for this month are on a good

scale, and for the latter part of the year the prospects promise a continuance of the present better position. At the same time, there is an uneasiness consequent upon fear of political interference with the coal trade of the country, although statements recently made indicate that no steps are to be taken that would be detrimental to the industry. The arrival of tonnage is slightly better, but is still much below requirements. Further large arrivals would certainly be a great help both to merchants and fitters, who, although this difficulty has not apparently influenced future business, are harassed by a consistent shortage of handy-sized vessels. There are fresh inquiries from New South Wales for coal, as the mining dispute continues there. Five cargoes of Northumberland steams were recently negotiated, amounting to about 40,000 tons, and there are inquiries for other six cargoes for the same destination, bringing the total up to about 100,000 tons. Chiefly because of the lack of prompt boats, Northumberland steam coal is being put on to the market in fairly considerable quantities, and prices are a shade easier. Best qualities are quoted at 14s. 6d. for prompt and 14s. 9d. forward. These are merchants' figures, fitters quoting 15s. Tyne primes are nominally easier, but unchanged at 14s. 6d., with seconds at 14s. The Durham gas coal trade is quietly steady without any outstanding demand. Some descriptions, especially inferior grades, are more plentiful, but, on the other hand, most of the collieries are well sold. Best gas coals are scarce and firm at 16s. 6d. Second gas brands are steady at 16s. to 16s. 3d. Except for the difficulty in obtaining tonnage, which impedes clearances, the coke position is satisfactory. Manufacturers are well sold and indicate firm prices. Ordinary foundry coke is obtainable at 19s. 6d., but up to 21s. is asked for some makes. Gas coke is in small supply at 21s. 6d. to 22s. Blast-furnace coke, following the re-kindling of more blast-furnaces, is firmly held at 6d. per ton higher.

Coal Trade Economic Position.

The latest accountancy figures regarding the state of the coal industry show that the economic position in Durham and Northumberland is slightly improved. In Durham the proceeds and costs in May would have provided that miners' wages in July would be 43·21 per cent. on the basis, as against 41·05 per cent. in June, an improvement of 2·16 per cent. The minimum additional percentage is 65, and therefore the deficiency to be made up is 21·79 per cent. As regards Northumberland, the report shows that the proceeds and costs in May, which would regulate wages in July but for the minimum clause in the county agreement, would provide 27·10 per cent. on basis wages, as against 26·93 per cent. in June, an improvement of 0·17 per cent. The minimum percentage addition is 40, and therefore the deficiency to be made up by the owners is 12·90 per cent.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE position in the shipbuilding industry has not changed to any extent during the past month. Outputs from Clyde yards continued on a large scale, with a resultant increase in unoccupied berths, owing to the scarcity of new orders. During the month of June thirty-one vessels of 48,740 tons aggregate were launched from Clyde yards, bringing the total for the half-year up to 119 vessels of 285,565 tons aggregate, compared with 114 vessels of 303,354 tons aggregate during the same period last year. The largest vessel launched was the "Western Prince," twin-screw motor ship, 12,000 tons, built for the Prince Line, Ltd., London. The returns also included three cargo steamers of about 5000 tons each, and three of about 4000 tons each; also numerous pleasure craft, the latter including the auxiliary schooner yacht "Sunbeam," 512 tons, built by Wm. Denny and Brothers, Dumbarton, for Sir Walter Runciman, Bart. The outlook is still most uncertain, and has naturally not improved since the costs of shipbuilding material have been increased. Contracts announced during last month included a twin-screw motor ship of 425ft. in length for Alfred Holt and Co., Liverpool; three motor tankers of 13,000 tons; and a single-screw passenger and cargo ship of 330ft. in length for the Union Steamship Company of New Zealand.

Steel.

There has been some improvement in the demand for heavy steel and some of the works are comparatively well booked for some weeks ahead. Sectional mills are benefiting from orders received for rails for South Africa. Orders for tubes have not been so prolific of late, but producers have plenty of business on hand, and regard the drop in orders merely as a seasonal decline. Sheet makers have a steady demand for the light gauges, but heavy varieties remain quiet. Prices are unchanged.

Iron.

Consumers of bar iron at home continue to purchase in small quantities for immediate use, and export is very dull. Steel re-rollers are now much quieter, and are met with stern competition from continental material. Bar iron prices are unchanged and re-rolled steel bars are about £8 home and £7 15s. per ton export.

Pig Iron.

The demand for hematite continues on a steady but small basis, while business in foundry grades is most unsatisfactory. Minimum prices are unchanged at 78s. hematite at steel works, 77s. No. 1 foundry, and 74s. 6d. No. 3 foundry at furnaces.

Scrap.

A quiet business is being done in scrap at about 75s. per ton for heavy steel and 70s. per ton heavy basic.

Coal.

The collieries in the West of Scotland are suffering from a general lack of orders for round coal, both for home and export. Best splints alone have bookings ahead, these being for the Irish market. Idle time is all too prevalent in this district. Almost similar conditions obtain in the Lothians. The situation in Fifeshire is better than in the other areas. Steams are well booked ahead, and exports would be heavier if the tonnage supply was adequate. More steamers are beginning to arrive now, but for some days it appeared as though outputs would have to be curtailed. In all districts small stuffs are comparatively scarce, and firm. Aggregate shipments for the week amounted to 259,566 tons, against 250,829 tons in the preceding week, and 223,215 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE position in the steam coal trade this week is less satisfactory, to put it mildly, and there is no doubt that numerous collieries are losing a considerable amount of working time, owing partly to the shortage in the demand for large coals, and in a great measure to the inadequacy of tonnage. Many orders which could not be executed last month as the result of exporters failing to secure the particular tonnage they required, are still held up, and, much to the chagrin of the exporters, rates of freight are still going against them. There appears to be a general shortage of tonnage, not only for outward business, but for homeward cargoes. Steamers up to about 4000 tons are most difficult to obtain. A few years ago owners of tonnage engaged in the short trades made such heavy losses and could see no prospect of conditions improving that comparatively few orders were placed with shipbuilders for handy-sized boats. Attention was concentrated on the construction of large steamers, and there is now no doubt that the market is feeling the inadequacy of small craft. This has been accentuated by the fact that so many boats of 2000 to 3500 tons have during the past two months been taken up on six months' time charter by the Russian Government. It is reported that sixty to seventy steamers have been taken, so that these are off the market for employment until practically the end of the year. It is not surprising therefore to find that the market for small tonnage has improved considerably, and exporters experience difficulty in satisfying their requirements. Business taken a month or so ago for the delivery of supplies of coal over the next few months and arranged on a c.i.f. basis is not showing good results at all, as outward rates in the near trades have advanced 1s. to 1s. 6d. per ton. Even for large-sized steamers the market is better for all directions than is usually the case at this time of the year. Unfortunately, the situation regarding tonnage is so uncertain that business is being hampered. Many exporters are declining to entertain new orders unless they can first of all get a definite offer of suitable tonnage; otherwise they regard the risk as too great. They are experiencing enough difficulty with the orders they already have in hand, without adding to their troubles for the time being. This attitude, of course, is not healthy for the coal trade generally and collieries are being handicapped.

Shipments and Tonnage.

Some idea of the situation is revealed by the returns as to the state of the local docks. At the end of last week there were as many as forty-eight idle tipping appliances and only one steamer was waiting. This is the worst return for some considerable time past. For the week ended June 28th the total coal exports as cargo to foreign markets came to just over 514,000 tons, which compared with nearly 538,000 tons in the preceding week. It is rather surprising that the reduction in shipments was not greater. Tonnage arrived over the week-end, and brought the number of idle tipping appliances down to twenty-two, but it will be appreciated that the situation at the docks from the loading point of view is far from satisfactory. Chartering has been a little more active, but not on a sufficient scale to bring about a return of active conditions at the docks. New inquiries for coals for prompt shipments are on very modest lines, while as regards contract operations, outside the fact that two of the Irish railways are reported to have bought about 50,000 tons each, for delivery over the remainder of this year, nothing of importance has happened.

Notices to Miners.

As a result of the depression in trade, fourteen days' notices were served on Monday on all except 60 of the 1500 men employed at the Great Western Collieries, which now belong to the Powell Duffryn Company. There are now about 4000 men in the Pontypridd district who are unemployed, so that if the present notices take effect, the unemployment situation in that area will be sadly aggravated. So far as can be learned, there is little prospect of the notices being withdrawn, though the miners' leaders and the tradesmen at Pontypridd are doing their utmost to persuade the company to refrain from closing the pits, if at all possible.

Current Business.

The tone of the market for large coals is extremely quiet, and most qualities are now on the minimum ruling prices. With large coals so inactive and numerous collieries as a consequence working irregularly, the supply of all other grades, such as smalls and sized coals, is inadequate to meet the demands, and prices are very firm. One or two collieries producing the best Admiralty descriptions are very well placed for orders and for tonnage, but they are the exception. Patent fuel is just about steady, while coke finds a ready outlet. Pitwood maintains a good tone owing to reduced importations, and prices are about 29s. 6d. to 30s.

CATALOGUES.

FERRANTI LTD., Hollinwood, Lancs.—Catalogue and price list of Ferranti electric fires.

STEWARTS AND LLOYDS, Ltd., 41, Oswald-street, Glasgow.—Catalogue of Oil Country Tubular Goods.

WAYGOOD-OTIS, Ltd., 54 and 55, Fetter-lane, E.C. 4.—A booklet describing the firm's lift and escalator factory.

J. H. SANKEY AND SON, Ltd., Essex Wharf, Canning Town, London, E. 16.—Folder dealing with "Pyruma" plastic fire cement.

IGRANIC ELECTRIC COMPANY, Ltd., Bedford.—Leaflet No. 1701 on solenoid operated brakes for alternating and direct-current service.

S. G. LEACH AND CO., Ltd., 26–30, Artillery-lane, E. 1.—Price list N.S. 106 of repulsion-induction and split-phase motors for alternating current.

TANGYES LTD., Cornwall Works, Birmingham.—Publication No. 363, illustrating some of the types of hydraulic jacks made by the firm for all purposes.

ENGLISH STEEL CORPORATION, Ltd., Vickers House, Broadway, W.C. 2.—Catalogue Section H, giving full particulars of Vickers' 600ft. portable drilling rig.

METALLIC MANUFACTURING COMPANY, Ltd., Ardrossan, near Glasgow.—A booklet illustrating various types of metallic jointings, disc valves and metallic packings.

DOUGLAS FRASER AND SONS, Ltd., Orchard-street, Arbroath, Scotland.—Folder on Douglas Fraser power transmission equipment, including patented spread-arm belt pulleys, plummer blocks, shaft couplings, Y hangers, and universal guide pulleys. A graph is included on "H.P. transmitted by leather belting per inch of width."

CONTRACTS.

THE ENGLISH ELECTRIC COMPANY, Ltd., has received an order from the Maidstone Corporation for seven six-wheel, double-deck, top-covered trolley omnibuses, each vehicle to have seating accommodation for fifty-six passengers.

RUTHS STEAM STORAGE, Ltd., of Africa House, Kingsway, London, W.C. 2, has received an order for a steam accumulator installation from Canning and Wildblood, Ltd. The same company has received an order for a steam accumulator installation from Price's Patent Candle Company, Ltd.

VICKERS-ARMSTRONGS, Ltd., have received from the Leith Harbour Commissioners an order for three 30-ton coal hoists for their Imperial and Edinburgh docks. One of these hoists is to be equipped with a "Norfolk Spade," an appliance specially designed for the rapid discharge of small coal or "duff" from wagons.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., has received the order for the wireless station which is to be erected in the Vatican city for the use of the Pope and the Vatican State. The station is to embody the latest improvements in wireless design and construction. Communication will be carried out both by telegraphy and by telephony on the short-wave broadcast principle and the range of the station is to be world-wide.

CALENDARS, DIARIES, &c.

HARLAND ENGINEERING COMPANY, Ltd., 72/74, Victoria-street, S.W. 1.—Wall calendar illustrating "Borehole Pumps." Mr. Heath Robinson has introduced a little relief to the calendar with a picture entitled "An early type of borehole pump for Horticulturalist's Water Supply."

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, Ltd.—Wall calendar with weekly tear-off slips.

COCHRAN AND CO. (Annan), Ltd., Annan, Scotland.—Wall calendar with monthly tear-off sheets.

THE NEWCOMEN SOCIETY.—This year the summer meeting of the Newcomen Society for the Study of the History of Engineering and Technology is to be held jointly with the Devonshire Association at Dartmouth, to commemorate the bicentenary of the death of Thomas Newcomen. It will take place on July 23rd to 26th. At 4.30 p.m. on July 23rd the members will be received by his Worship the Mayor, Dr. H. J. Campbell, and Corporation, in the Subscription Rooms. The members will then proceed to the Newcomen Memorial in Town Gardens, where a eulogy of Newcomen will be pronounced by the President of the Newcomen Society, Mr. L. St. L. Pendred. At 8.30 p.m. Dr. G. P. Bidder, President of the Devonshire Association, will deliver an address. Wednesday and Thursday will be devoted to excursions, and on Thursday evening Capt. E. C. Smith, O.B.E., R.N., will lecture on "Thomas Newcomen: Two Hundred Years of Steam Power," in the Subscription Rooms. Excursions will also take place on Friday, July 26th.

A JAPANESE RAILWAYMEN'S DINNER.—At the invitation of Mr. S. Suzumura, who is Resident Representative in this country of the Ministry of Railways of the Imperial Japanese Railways, we had the pleasure of attending a dinner at the Hyde Park Hotel on Thursday, June 27th. The banquet had two objects:—The first was to bid "Farewell" to Mr. T. Nagata, lately in charge of the Civil Engineering Department of the London office of the Japanese Railways, who is about to return to Japan; to Mr. S. H. Hunt, late Vice-President of the L.M.S.R.; and to Mr. Alex. Wilson, retiring Divisional General Manager, L.N.E.R. The second object was to "Welcome" first His Highness Prince Shimazu, who has lately come to this country as Naval Attaché, but who was unfortunately unable to be present; then Mr. Y. Kihara who has come from Japan to succeed Mr. Nagata; Lieut.-Colonel A. H. L. Mount, lately appointed Chief Inspecting Officer of Railways at the Ministry of Transport; Mr. F. G. Evans, Vice-President L.M.S.R.; Mr. O. Glynne Roberts, Secretary, L.M.S.R.; Mr. R. Carpmael, new Chief Engineer, G.W.R.; and Mr. G. F. Thurston, Divisional General Manager, L.N.E.R. The toast of "Farewell" was proposed by Mr. T. B. Kabashima, who is in charge of Mechanical Engineering in the London office, while that of "Welcome" was submitted by Mr. Suzumura from the Chair. Both the speeches were delivered in perfect English, as indeed were the other speeches made during the evening by Japanese gentlemen, and we could not help wondering what sort of a job English engineers would have made of it if called upon to deliver similar speeches on a like occasion in Japan! After these toasts had been offered and responded to the health of the Chairman was proposed by Lieut.-Colonel G. S. Szlumper and drunk enthusiastically, as had been the toasts of the King and the Emperor of Japan earlier in the evening. At the close of the speeches there was a film exhibition of the adoption of automatic couplers on the Japanese railways, and of glimpses of Japanese scenery and customs. Altogether it was a most successful, entertaining and enjoyable evening.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/6 to 22/–
(1) Spanish	24/–
(1) N. African	24/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	23/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 18 0	—
No. 1 Foundry	3 17 0	—
No. 3 Foundry	3 14 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 14 0	3 14 0
No. 1	3 14 6	3 14 6
Cleveland—		
No. 1	3 15 0	3 15 0
Silicious Iron	3 15 0	3 15 0
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 11 6
No. 4 Forge	3 11 0	3 11 0
Mottled	3 10 6	3 10 6
White	3 10 6	3 10 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 11 0	—
„ „ Foundry	3 13 6	—
(3) Northampton—		
Foundry No. 3	3 10 0 to 3 12 6	—
Forge	3 6 0 to 3 8 6	—
(1) Derbyshire—		
No. 3 Foundry	3 8 6 to 4 1 0	—
Forge	3 4 6 to 3 17 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 12 6	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 5 0 (*a*) / 4 7 6 (*b*) / 4 11 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 15 0	—
Second Quality Bars	10 0 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	11 0 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ¾in. and up	8 12 6	7 12 6
Sections	8 2 6	7 2 6
Steel Sheets, ¼in.	9 0 0	8 12 6
Sheets (Gal. Cor. 24 B.G.)	13 17 6	13 12 6 to 13 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 12 6	—
Angles	8 2 6	—
Boiler Plates	12 15 0	—
Joists	8 2 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 2 6	—
„ (Small Round)	8 5 0 to 8 10 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 12 6 to 9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	7 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	8 10 0	—
MIDLANDS—		
Small Rolled Bars	8 5 0 to 8 15 0	—
Billets and Sheet Bars	6 12 6 to 6 15 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 10 0 to 13 15 0	—
Angles	8 2 6	—
Joists	8 2 6	—
Tees	9 2 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 17 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/3 to 18/6
Block Tin (cash)	201 5 0
„ „ (three months)	205 0 0
Copper (cash)	73 7 6
„ (three months)	73 0 0
Spanish Lead (cash)	23 7 6
„ „ (three months)	23 6 3
Spelter (cash)	25 8 9
„ (three months)	25 8 9
MANCHESTER—	
Copper, Best Selected Ingots	77 5 0
„ Electrolytic	84 15 0
„ Strong Sheets	110 0 0
„ Tubes (Basis Price), lb.	0 1 3½
Brass Tubes (Basis Price), lb.	0 1 1½
„ Condenser, lb.	0 1 3½
Lead, English	24 12 6
„ Foreign	23 5 0
Spelter	25 12 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/– per lb.	
Ferro Tungsten	2/9 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	7/6
„ „ 6 p.c. to 8 p.c.	£23 0 0	7/–
„ „ 8 p.c. to 10 p.c.	£23 0 0	6/6
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£34 0 0	12/–
„ „ „ 1 p.c. carbon	£38 0 0	15/–
„ „ „ 0·70 p.c. carbon	£42 0 0	17/–
„ „ „ carbon free	1/2 per lb.	
Metallic Chromium	2/6 per lb.	
FerroManganese (per ton)	£13 15 0 for home; £13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/– per unit	
„ „ 75 p.c.	£19 10 0 scale 6/– per unit	
„ Vanadium	13/– per lb.	
„ Molybdenum	4/– per lb.	
„ Titanium (carbon free)	1/– per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/4 per lb.	

FUELS.

SCOTLAND.
(*Prices not stable.*)

	Export.
LANARKSHIRE	
(f.o.b. Glasgow)—Steam	13/–
„ „ Ell	14/–
„ „ Splint	15/6 to 16/–
„ „ Trebles	14/6
„ „ Doubles	13/3
„ „ Singles	12/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/3
„ „ Jewel	16/6
„ „ Trebles	13/9
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	12/– to 14/6
Screened Navigation	17/6
Trebles	15/6
Doubles	13/6
Singles	12/–
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/–
Secondary Steam	12/6
Trebles	14/–
Doubles	13/6
Singles	12/3

ENGLAND.

	Inland.
(8) N.W. COAST—	
Steams	24/– to 25/–
Household	38/– to 51/–
Coke	23/6 to 25/–
NORTHUMBERLAND—	
Best Steams	14/6 to 15/–
Second Steams	13/9 to 14/–
Steam Smalls	9/6 to 10/6
Unscreened	13/– to 13/6
Household	21/– to 26/–
DURHAM—	
Best Gas	16/6 to 16/9
Second	16/– to 16/6
Household	21/– to 27/–
Foundry Coke	22/– to 28/–
SHEFFIELD—	
Best Hand-picked Branch	27/– to 28/6 —
Derbyshire Best Bright House	20/– to 23/– —
Best House Coal	19/6 to 20/6 —
Screened House Coal	17/6 to 18/6 —
„ „ Nuts	16/– to 17/6 —
Yorkshire Hards	15/6 to 16/6 —
Derbyshire Hards	15/6 to 16/6 —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	6/– to 7/– —
Smalls	2/– to 4/– —
Blast-furnace Coke (Inland)	14/6 at ovens —
Furnace and Foundry Coke (Export), f.o.b.	20/– to 21/–

CARDIFF— (9) SOUTH WALES.

Steam Coals :	
Best Smokeless Large	19/9 to 20/–
Second Smokeless Large	19/6 to 19/9
Best Dry Large	18/9 to 19/–
Ordinary Dry Large	18/– to 18/6
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/– to 18/3
Best Eastern Valley Large	17/9 to 18/–
Ordinary Eastern Valley Large	17/3 to 17/9
Best Steam Smalls	13/9 to 14/3
Ordinary Smalls	12/6 to 13/–
Washed Nuts	20/– to 23/6
No. 3 Rhondda Large	20/– to 21/–
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/– to 17/6
„ „ Through	16/– to 17/–
„ „ Smalls	13/6 to 14/–
Foundry Coke (Export)	26/6 to 36/–
Furnace Coke (Export)	21/– to 23/–
Patent Fuel	20/– to 21/6
Pitwood (ex ship)	29/6 to 30/–
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	33/– to 36/6
Seconds	27/6 to 30/–
Red Vein	23/– to 27/–
Machine-made Cobbles	40/– to 44/–
Nuts	40/– to 44/–
Beans	23/6 to 25/6
Peas	18/– to 19/–
Breaker Duff	9/– to 9/6
Rubbly Culm	10/3 to 10/9
Steam Coals :	
Large	18/– to 19/–
Seconds	17/– to 18/–
Smalls	10/6 to 13/–
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/– extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated.
Coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield.
(*c*) Delivered Birmingham (*d*) Rebate 12/6 joists and 10/– all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

Trade Situation.

IT may be desirable to refer once more to the change which is taking place in the situation of the French metallurgical and engineering industries as the result of the new economic conditions arising out of a gradual return to the level of the world's gold standard. There are many who fear that the change will have serious consequences for foreign trade. Everything is being done to adapt industry to the new conditions by providing cheap motive power, lowering freights and reducing production costs by standardisation, but, while the results of these efforts cannot yet be estimated, it is certain that there continues to be an inflation of values and costs are increasing. Metallurgical products have, so far, resisted the further upward movement, but they always have a tendency to harden, and there have been no advances because it is not usual to declare them just before the holiday season. Negotiations are in progress for the creation of a *comptoir* for sheets which, if successful, will inevitably result in higher prices. While values of material are strongly upheld, there is more activity in the engineering trades, the motor car industry being especially busy. All the motor car firms are behindhand with deliveries. In the electrical engineering industry there is also plenty of work. American capital continues to extend its operations in this branch, and a new company is being formed with the participation of Schneider et Cie, who will make over to the new concern their works at Champagne-sur-Seine, and will have a majority of the capital, so that Creusot obviously aims at developing the electrical branch of its activities. It is feared that this industrial prosperity will not last if manufacturers find their increasing costs aggravated by the new charges which the Government intends to impose upon them. While it is stated that taxes, generally, are to be reduced, the charges on industry are growing, and efforts are being made to convince the country that unless industry gets some relief it will be quite unable to regain the position it is losing in foreign markets. So hopeless is the new law, which is intended to provide funds for the payment of increased pensions to the miners, that no one expects that it will be possible to put it into operation. Notwithstanding these fiscal problems it is not easy to see how they can be avoided altogether.

Foreign Trade.

The monthly returns of foreign trade are of special interest as showing that a definite change has taken place in the country's commercial situation. Until towards the end of last year there had nearly always been a good balance of exports over imports, and that was regarded as an indication of national prosperity, and, now that the prosperity is more pronounced than it was before, the increasing value of imports over exports is growing every month. The imports during the first five months of the year were valued at 25,474 million francs, an augmentation of 3905 million francs as compared with the corresponding period of 1928. The exports totalled 20,378 million francs, a decline of 661 million francs. There were heavy increases in the imports of manufactured goods and raw material, the increases being due principally, if not wholly, to goods supplied by Germany on account of reparations. The exports of manufactured goods increased by 54,099 tons, but there was a decline in value of no less than 319 million francs.

Trans-Pyrenees Railways.

The second railway which will traverse the Pyrenees from Ax-les-Thermes to Tour de Carel in Spain is practically completed, and will be put into service during the present month. For a distance of 25 miles it is carried over viaducts and bridges and through tunnels, with gradients of 40 mm. per metre—or 1 in 25—and curves with radii of 200 m.—say, 650ft. Spiral tunnels traverse the Saillens and Puymorens, the latter having a length of a little more than three miles. This section of the line will, of course, be worked electrically. For the present, there will be a changing of trains at the international station of Tour de Carel owing to the difference of gauge, but the Spanish railway company has been authorised to change the gauge from 1·64 m. to 1·44 m. so that trains can be run through from France to Barcelona.

Sahara Motor Traffic.

During the past few years a good deal of exploration work has been carried out with motor cars in the Sahara desert, and the six-wheeled Renault vehicles appear to have given quite satisfactory results; a number of journeys across the desert between Algeria and the Niger have already been effected. A definite route has now been surveyed between Colomb-Bechar and Gao, and a regular service of motor cars is to be run by the Compagnie Générale Transsaharienne, which has for some years organised touring circuits in conjunction with the railway companies. The service is to be extended to Timbuctoo and Bamako, with ramifications to Equatorial Africa and the Belgian Congo. Although it is claimed that the services will have a commercial value, it is clear that the company relies more particularly upon the transport of tourists to the centre of Africa, for which purpose hotels are to be built at Gao on the Niger and elsewhere.

Bridges.

On account of the periodical floods of the river Song-Darang in Indo-China, in which the volume of water sometimes reaches 15,000 cubic metres a second and famine is prevalent through the impossibility of crossing the river, the Government has constructed four reinforced concrete bridges between Tourane and Nhatrang. The work was accomplished under great difficulties, the floods occasionally carrying away parts of the structure, but now that the bridges are completed the currents are declared to be so far regulated as to lessen the seriousness of the inundations of territories watered by the river.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

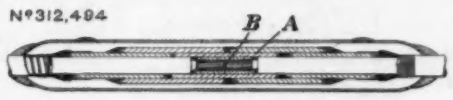
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TRANSMISSION OF POWER.

312,494. May 25th, 1928.—JOINTS OF ELECTRIC CABLES, W. T. Henley's Telegraph Works Company, Ltd., Holborn-viaduct, London, E.C. 1, and P. Dunsheath.

The invention concerns the insulating wrapping A of paper round the cable joint at B. This wrapping is made in the form of a coil with an internal diameter greater than that of the cable. It is slipped in place and is then tightened up by stroking it round. The necessary initial grip between the cable and the inner coil of the paper is obtained either by pressure with a thin tool or

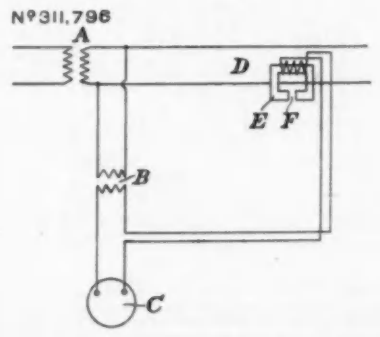


by means of an adhesive. It is stated that "it is found that when the tightening process is commenced, the tube which initially has an internal diameter appreciably greater than that of the surface on to which it is to be tightened, and has its layers closely wrapped together, assumes an open condition in its innermost part, which is then removed by a tightening action extending outwards from the inner layers until finally a very compact tube tightened down on to its support is obtained." In another part of the specification the word outer takes the place of innermost.—*May 30th*, 1929.

MEASURING AND TESTING INSTRUMENTS.

311,796. February 14th, 1928.—MEASURING APPARATUS FOR HIGH-TENSION CIRCUITS, The International General Electric Company, New York, and C. G. Mayo, of 17, Alexandra-road, Rugby.

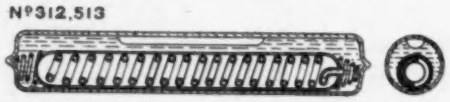
This invention relates to measuring instruments and protective relays for use in electric distribution or transmission systems, particularly those which are adapted for operation at high potentials of, say, 132 kilovolts. It describes a method of obtaining the exact measure of the voltage on the high-pressure side of a power transformer from the low-pressure side. As shown in the drawing to the low-pressure side of the power transformer A there is connected the potential transformer B, which supplies the measuring instrument C. This instrument



gives an exact indication of the voltage at the high-pressure side of transformer A. In order to compensate for the reactance of the transformer A under varying load conditions, a reactor D is connected in the circuit to the instrument C. This reactor comprises a core E, provided with an air gap F, which also allows the reactor to be positioned around one of the power transformer leads on the low-pressure side of that transformer. If desired, however, it may be associated with one of the high-pressure conductors. The reactor D thus operates as a current transformer, the secondary voltage of which is in proportion to the primary current. The drawing shows a single-phase circuit from which the connections for a polyphase circuit may be deduced.—*May 14th*, 1929.

312,513. June 22nd, 1928.—SPIRIT LEVELS, H. T. Tallack, 286, High Holborn, W.C. 1.

This invention relates to spirit levels such as are used with surveying and other precision instruments which have the air space long and narrow. Variations of temperature alter the bulk of the liquid, and the expansion or contraction when the liquid greatly exceeds the bulk of the air causes the air space to alter in length, and for very precise work that is undesirable. It is well known that certain proportions of air and spirit or other suitable liquid will counteract each other, so that the air space remains practically the same over a fairly large range of temperature, but this proportion is such that with an ordinary

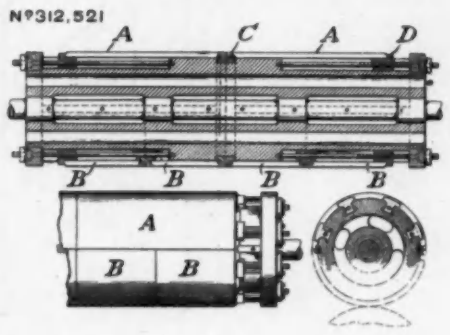


circular section tube of ordinary length the air space extends the whole length of the tube. To obviate this, either less spirit must be contained in the tube or more air, and the invention consists in making provision for the greater quantity of air while maintaining the size of the air bell, as seen of ordinary proportions. The outer glass tube is the same as all ordinary tubular spirit levels; within this tube there is inserted a tubular air chamber of sufficient length and diameter to contain the extra amount of air required. This chamber is completely closed, with the exception of a small opening at one end. Sealed to this opening is one end of a very small tube. This tube, preferably in the form of a spiral, practically reaches from end to end of the internal space of the chamber, both ends of the tube being open, the one end to the interior of the chamber and the other end to the interior of the bubble tube. The action of this combination is that as the liquid in the bubble tube expands, it is forced against the air cushion within the chamber into the spiral inner tube, and as the liquid contracts, the pressure of the air cushion forces it out again into the bubble tube. It is most important that the spiral inner tube is of sufficient length to contain the liquid expanded by the highest likely temperature, as should any liquid be forced right through and into the air chamber, it would not be forced out again by the air cushion when the liquid contracted again. The air chamber, being circular in section, always rolls to the bottom of the bubble tube, so that it can be used equally well in a reversible spirit level, and its diameter is such that its top is always well below the level of the spirit under the air bell.—*May 30th*, 1929.

MACHINE TOOLS AND SHOP APPLIANCES.

312,521. June 25th, 1928.—CLAMPING PLATES ON PRINTING CYLINDERS, *R. Hoe and Co., Ltd.*, 109, *Borough-road, London, S.E.* 1.

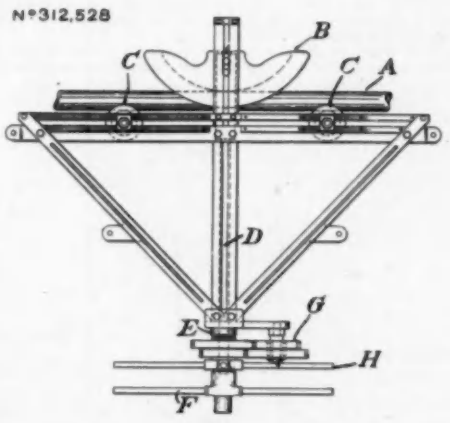
The object of this invention is to provide a surface on printing rolls which will print a continuous pattern and yet may be readily changed without lifting out the roll. The plates are



divided so that two plates A A cover one-half of the periphery, and four others B B B B cover the other half. The plates are held in position by dovetail rings C and clamping rings D. The edges of the plates are, of course, trimmed to abut closely. In this way provision is made for the quick changing of all, or sections, of the printing surface.—*May 30th*, 1929.

312,528. July 6th, 1928.—PIPE-BENDING MACHINES, J. E. Jackson, 28, Henbury-street, Moss Side, Manchester, and J. Lord, 11, Mattison-street, Higher Openshaw, Manchester.

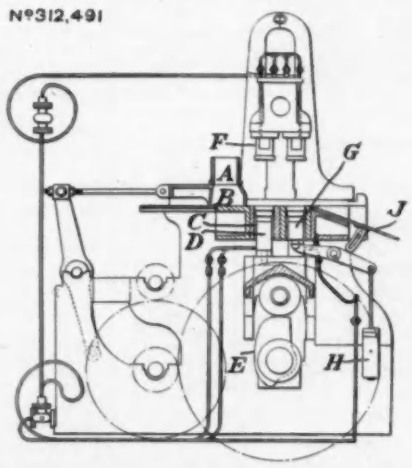
In this bending machine the pipe or bar A is bent round the forming block B by pulling the block towards a framing carrying



two rollers C C. The necessary pull is provided by the screw D. To this extent the machine is not unusual. The nut E for the screw is, however, provided with alternative drives, one directly by means of the hand wheel F, and the other through a train of gear wheels G from the hand wheel H. With this gear an extra purchase is obtained for bending large pipes.—*May 30th*, 1929.

312,491. May 24th, 1928.—BRICK-MAKING MACHINES, Clayton, Goodfellow and Co., Ltd., Atlas Ironworks, Blackburn, and T. Whittaker, 7, Kew-gardens, Penwortham, Preston.

This brick-making machine is of the type in which the semi-



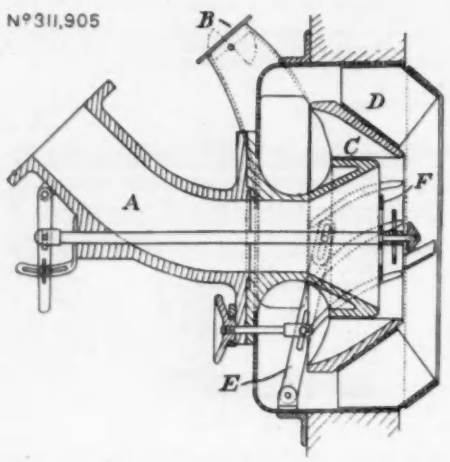
plastic clay is pressed in a steam-heated mould. The clay is fed through the shoot A into the hopper B, which is slid across the table by the gear shown to drop the clay into the first pressing

box C. The bottom of this box is formed by the ram D, which is reciprocated by the cam E. (In the drawing the ram is shown in its top position.) The upper ram F then descends and compresses the brick, the lower ram rises and ejects it from the mould, and the hopper pushes it forward over the second pressing mould G. The lower ram of this mould is supported by the counterweight H, and consequently provides a flat table for the reception of the brick. The upper ram then descends again and recompresses the brick. Finally, it is ejected and slides down the shoot J.—*May 30th*, 1929.

FURNACES.

311,905. April 14th, 1928.—PULVERISED FUEL BURNERS, Babcock and Wilcox, Ltd., Farringdon-street, London, E.C. 4, and C. H. Davy, 72, The Avenue, Beckenham, Kent.

This burner is of the type in which the pulverised coal is supplied by way of the branch A with such air as is necessary to keep it in motion. Secondary air is supplied by the duct B

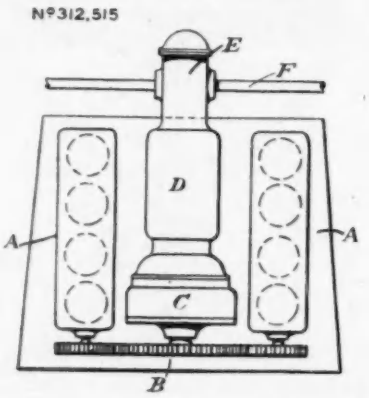


to the two concentric impellers C and D. These impellers may be moved in an axial direction by the linkwork E, so as to regulate the amount of air supplied by the impeller C, while that delivered by D remains constant. At the outlet of the burner there are retarders F, which may be adjusted as to position, to reduce the speed of the combustible mixture to any desired extent.—*May 23rd*, 1929.

MOTOR CARS AND ROAD TRAFFIC.

312,515. June 23rd, 1928.—MOTOR CAR POWER PLANTS, The Alvis Car and Engineering Company, Ltd., and G. T. Smith-Clarke, Holyhead-road, Coventry.

The object of this invention is to provide a very compact power plant for motor vehicles. Two engines are employed, as

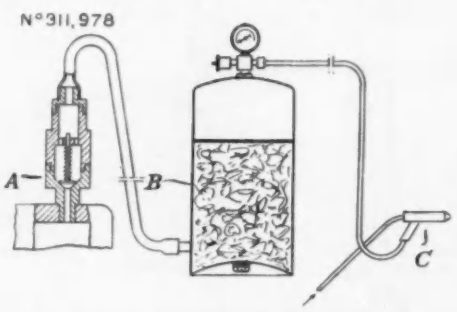


shown at A A, and they drive a central shaft through speed-reduction gearing B. On this shaft there is a friction clutch C, a speed-changing gear-box D, and a bevel gear E, which drives the transverse shaft or axle F.—*May 30th*, 1929.

MISCELLANEOUS.

311,978. July 5th, 1928.—COMPRESSING AIR FOR SPRAYING DEVICES, F. Johns, 53, Jardin-street, Camberwell, London, S.E., and B. Mesnard, 35, Albany-road, Camberwell.

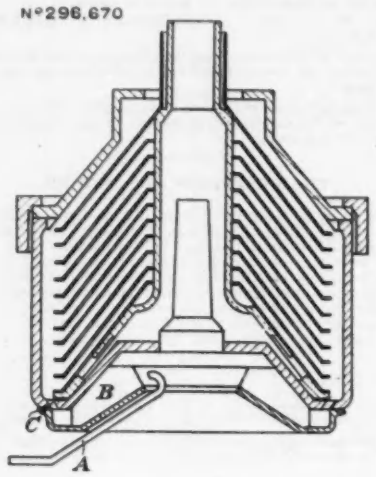
The inventors propose to utilise air compressed by the engine of a motor car for the purpose of operating a spraying jet for



painting the car itself. One of the cylinders of the car is used as a compressor and delivers air through the valve A to the filter B, and thence to the spray C. No mention is made as to whether or not the supply of fuel to the cylinder being used as a compressor is interfered with.—*May 23rd*, 1929.

296,670. August 27th, 1928.—CENTRIFUGAL SEPARATORS, Aktiebolaget Separator, Fleming-gatan 8, Stockholm, Sweden.

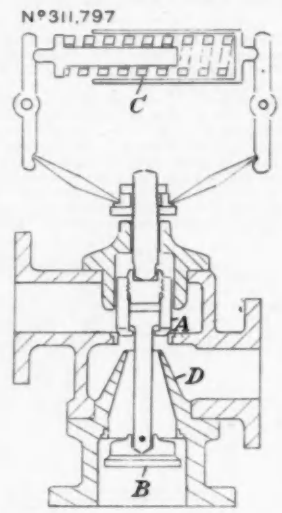
The object of this invention is to obviate the necessity for occasionally dismantling a centrifuge, used for separating solid



impurities from oil, for the purpose of cleaning out the impurities. The inventors consequently occasionally feed water or brine into the bowl by the pipe A. This water is thrown out by the impellers B, through the openings C and so washes away the impurities.—*May 23rd*, 1928.

311,797. February 15th, 1928.—VALVES, H. L. Mason, 103, King Henry's-road, South Hampstead, London, N.W. 3.

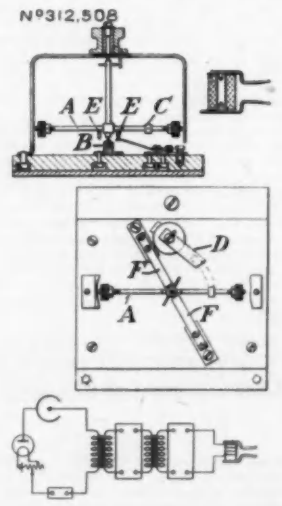
This is a peculiar specification, and one is left in doubt as to several matters, as there are three branches and no hint is given as to the direction of flow. It appears, however, that A is the main



valve, and is actuated by the valve or disc B, in opposition to the spring C. The novelty, it may be assumed, lies in the introduction of the cone D, above the valve B. This cone, it is said, accentuates the pressure difference when the valve moves and consequently makes it more dead beat.—*May 15th*, 1929.

312,508. June 12th, 1928.—APPARATUS FOR CONTROLLING MECHANISM BY MEANS OF LIGHT, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C. 2, and E. M. Eden.

It is suggested that the turbidity of a liquid can be determined



with the assistance of a photo-electric cell, which receives no direct light through a clear liquid, but is illuminated by the scattered light which passes through when the liquid is turbid. The impulse provided is, however, very weak, so the relay illustrated is inserted in the circuit. The beam A, mounted on the jewel B, is provided with a soft iron armature C, which works in conjunction with the electro-magnet D. The axis of the beam is set very slightly out of the vertical, so that it has a bias away from the magnet. If the attractive force of the magnet, which is energised by the photo-electric cell, weakens, the beam swings round, and the contacts E E and F F complete a circuit for any indicating or other purpose. The specification includes a diagram of the connections from the cell, through a valve and amplifiers to the electro-magnet.—*May 30th*, 1929.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

BRITISH WATERWORKS ASSOCIATION.—Portsmouth. For programme see page 447, April 19th, 1929.

INDUSTRIAL WELFARE SOCIETY.—Eighth annual conference of Editors of Works Magazines at Norwich.

INSTITUTION OF CIVIL ENGINEERS.—Birmingham and District Association. Visit to Liverpool to see the work in connection with the Mersey Tunnel. Leave New-street Station at 8.30 a.m.

OVERHEAD LINES ASSOCIATION.—Visit to the Mid-Cheshire Electricity Supply Company. The visit will start at 12.15 p.m. at Winsford (Gravel) Station (L.M. and S.).

SATURDAY, JULY 6TH.

PHYSICAL SOCIETY.—Visit to Birmingham. The following programme has been provisionally arranged :—Leave Paddington 9.10 a.m., arrive Leamington 10.44 a.m. On arrival at Leamington the party will drive by motor omnibus, provided by the University, to Birmingham *viâ* Warwick. At Warwick a stop will be made to enable members to inspect Warwick Castle and other places of historic interest. Lunch will be taken at the University Refectory in the Edgbaston Buildings about 1.30 p.m., and thereafter the meeting will be held and the University Science Buildings will be open to inspection.

TUESDAY TO SATURDAY, JULY 9TH TO 13TH.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—Royal Show at Harrogate.

WEDNESDAY, JULY 10TH.

MANCHESTER ASSOCIATION OF ENGINEERS.—Visit to Agecroft Power Station, City of Salford Electricity Works. 3 p.m

WEDNESDAY TO FRIDAY, JULY 10TH TO 12TH.

ELECTRICAL ASSOCIATION FOR WOMEN.—Fourth Annual Conference at the North-East Coast Exhibition, Newcastle-on-Tyne.

INSTITUTION OF MINING ENGINEERS.—Eighty-ninth general meeting at Nottingham.

TUESDAY TO SATURDAY, JULY 16TH TO 27TH.

AIRCRAFT EXHIBITION.—Olympia. Seventh International Aircraft Exhibition.

TUESDAY TO THURSDAY, JULY 23RD TO 25TH.

NEWCOMEN SOCIETY.—Summer meeting at Dartmouth, Devon. For programme see page 25.

SATURDAY TO TUESDAY, AUGUST 3RD TO 13TH.

INSTITUTION OF ELECTRICAL ENGINEERS : LONDON STUDENTS' SECTION.—Summer Tour, 1929. The tour will be held this year in Paris and Northern France.

TUESDAY TO FRIDAY, SEPTEMBER 10TH TO 13TH.

IRON AND STEEL INSTITUTE.—Autumn meeting at Newcastle-on-Tyne.

THURSDAY TO SATURDAY, SEPTEMBER 12TH TO 28TH.

SHIPPING, ENGINEERING AND MACHINERY EXHIBITION, Olympia.

SATURDAY TO SATURDAY, SEPTEMBER 14TH TO 28TH

INSTITUTION OF NAVAL ARCHITECTS.—Summer meeting in Italy. For programme see page 380, April 5th, 1929.

THURSDAY, JULY 11TH.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Evening visit to the Scott Motor Cycle Company, Shipley, at 7 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. H. H. FANTHORPE, who recently resigned from the position of managing director of Yates-American Machine Company, Ltd., has joined the staff of Thomas Robinson and Son, Ltd., of Rochdale. He will act as sales representative for the South-Eastern and Eastern Counties.

MAJOR F. A. FREETH, D.Sc., F.R.S., late manager of the Research Department of Brunner, Mond and Co., Ltd., Winnington, and Mr. Wm. Rintoul, F.I.C., manager of the Research Department of Nobel's Explosives Company, Ltd., Ardeer, have been appointed joint research managers to Imperial Chemical Industries, Ltd., Millbank, London, S.W.

H. V. MCKAY PTY., Ltd., of Sunshine, Australia—manufacturers of the Sunshine harvesting machinery—known under the trade mark "La Australiana"—and Agricultural and General Engineers, Ltd., of Aldwych House, London, have entered into an agreement by which Agricultural and General Engineers, Ltd., will undertake the sole selling arrangements of the Sunshine Harvesting Machinery in South America.

ANDREWS TOLEDO, Ltd., of Sheffield, asks us to announce that it has taken over the works and assets, as a going concern, as from November 3rd, 1928, of the old established firm of Jno. Hy. Andrew and Co., Ltd. The board will comprise Messrs. J. F. Parker (chairman), G. St. J. Strutt, and Engineer Vice-Admiral Sir George Goodwin, K.C.B., LL.D. The new company is immediately embarking upon a policy of modernising the various departments of the Toledo Steel Works at Sheffield.

THE ROYAL AERONAUTICAL SOCIETY.—At a Council meeting of the Royal Aeronautical Society, with which is incorporated the Institution of Aeronautical Engineers, Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S., was elected President for the year October, 1929–1930; Air Vice-Marshal Sir Vyell Vyvyan, K.C.B., D.S.O., ; Lieut.-Colonel J. T. C. Moore-Brabazon, M.C., F.R.Ae.S., M.I.Ae.E. ; and Mr. H. E. Wimperis, F.R.Ae.S., were elected Vice-Presidents of the Society for the year October, 1929–1930.